EXTRACTED VERSION

OPERATION CASTLE

Radiological Safety

Final Report

Volume I

Headquarters
Joint Task Force Seven
Technical Branch, J-3 Division
Washington, DC

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This report is designed to cover the overall Operation Castle radiological safety matters from the viewpoint of those issues of direct concern to Headquarters, Joint Task Force Seven. It was written for the express purpose of assisting in the development of future radiological safety plans by presenting detailed discussion of the problems and solutions arising during Operation Castle. Included is a discussion of fallout forecasting techniques.

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FINAL REPORT

RADIOLOGICAL SAFETY

OPERATION CASTLE

Prepared by Technical Branch, J-3 Division
Headquarters, Joint Task Force SEVEN
Washington 25, D. C.

FOREWORD

Classified material has been removed in order to make the information available on an unclassified, open publication basis, to any interested parties. The effort to declassify this report has been accomplished specifically to support the Department of Defense Nuclear Test Personnel Review (NTPR) Program. The objective is to facilitate studies of the low levels of radiation received by some individuals during the atmospheric nuclear test program by making as much information as possible available to all interested parties.

The material which has been deleted is either currently classified as Restricted Data or Formerly Restricted Data under the provisions of the Atomic Energy Act of 1954 (as amended), or is National Security Information, or has been determined to be critical military information which could reveal system or equipment vulnerabilities and is, therefore, not appropriate for open publication.

The Defense Nuclear Agency (DNA) believes that though all classified material has been deleted, the report accurately portrays the contents of the original. DNA also believes that the deleted material is of little or no significance to studies into the amounts, or types, of radiation received by any individuals during the atmospheric nuclear test program.

ACKNOWLEDGEMENTS

A report of this type must of necessity involve the gratuitous assistance of several individuals outside the Technical Branch, J-3 of the Task Force Headquarters. It is considered fitting and proper that individual contributions to the effort be acknowledged as follows:

Dr. Gaelon Felt (J-Div, LASL & TG 7.1)	For the development and use during the CASTLE Operation of a new technique of forecasting long-range fall-out based on progressive time and space changes in the wind pattern and for the preparation of the discussion on this method attached as Inclosure 2 to Tab D.
Dr. Thomas N. White (H-Div, LASL & TG 7.1)	For the development and use during the CASTLE Operation of a new technique of forecasting close-in fall-out based on a mathematical distribution approach to the problem and for the preparation of the discussion on this method attached as Inclosure 3 to Tab D.
LtCol Carlos D. Bonnot (Hq, JTF SEVEN)	For the preparation of the weather summaries, wind tabulations and forecast air particle trajectories appearing in Tabs K through P, and for a considerable amount of proof-reading and suggestions.
Capt Russel H. Maynard (Hq, AFSWP)	For daily assistance and suggestions relative to Radsafety operations during CASTLE, for the post-shot analysis of the BRAVO fall-out pattern, for the preparation of the forecast fall-out plots by elliptical approximation, and for a considerable amount of proof-reading and suggestions.
Col Clinton S. Maupin (Hq, JTF SEVEN)	For daily assistance and suggestions relative to the medical aspects of Radsafety during the CASTLE Operation and for the preparation of the discussion of medical aspects of BRAVO in Tab K.
Col Paul R. Wignall	For suggestions on the development of the cloud tracking plan, for monitoring the cloud tracking efforts during the CASTLE Operation and for the discussions and analyses of these efforts appearing in Tabs K through P.
Mr. A. Breslin	For frequent assistance and information relative to the long-range CASTLE fall-out measurements made by the Health and Safety Laboratory New York Operations Office, AEC.

Acknowledgement is made of the many others who had either a direct or an indirect influence on the CASTLE Radsafety operations and the material reflected in this report, and whose contributions, both large and small, greatly assisted this documentation, It is considered especially fitting to acknowledge those who assisted in the tedious administrative and clerical work of assembling the many items of information, charts, statistics, etc. In particular, acknowledgement for this latter category is made to YN1 John A. Nevling, Chief Clerk, Technical Branch, for invaluable assistance during the CASTLE Operation in the preparation of large quantities of briefing and documentary material, and for similar assistance in the preparation and assembly of this report.

RICHARD A. HOUSE
Lt Colonel, USAF
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Joint Task Force SEVEN

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PART ONE: GENERAL

1. This report is divided into five parts. Part ONE is a general description of the report. Part TWO is a discussion of the radiological safety problems created by the CASTLE mission of the task force, and their solutions as planned and executed during the shot phase of the operation. Part THREE is a discussion of fall-out forecasting techniques. Part FOUR depicts the Radsafe organization. Part FIVE is a discussion of conclusions drawn from the execution of the CASTLE radiological safety plan and recommendations for future operations similar to Operation CASTLE.

2. The report is designed to cover the over-all CASTLE radiological safety matters from the viewpoint of those issues of direct concern to Headquarters, Joint Task Force SEVEN. Since each task group was responsible for its own internal radiological safety as generally defined in CJTF SEVEN Operation Order 3-53 (Tab A), no attempt will be made herein to amplify on the details of the operations of the task groups except as they pertain to, or directly support, the responsibilities of the task force as a whole. However, due to the basic reliance of task force operations on floating facilities in the test area, the radiological safety portion of the TG 7.3 final report has been extracted and appended hereto. The radiological safety details of TG 7.1 shot atoll operations are being published separately as a WT report and will be available approximately September 1954. The TG 7.1 report will include full details on photodosimetry, radiochemical work performed on-site, shot atoll radsafe surveys and recovery operations.

3. This report has been written for the express purpose of assisting in the development of future radiological safety plans by presenting detailed discussions of the problems and solutions arising during CASTLE. As such,

the report has a primary operational viewpoint, and frequently departs in phraseology and precision from the normal standards prescribed for a purely technical document. Since various independent technical investigations have been completed, or are in process, which closely examine the many facets of the radiological effects of the CASTLE events, the need for a coverage of the operational viewpoint appears vital for continuity and development of better operational means of coping with the problems.

4. The following general information on special aspects of the CASTLE Operation is presented as background for Parts TWO, THREE, FOUR and FIVE.

a. Seven detonations had been scheduled when the task force arrived in the Pacific Proving Grounds. Five of the original seven, plus one substitute, were actually detonated.

b. The planning date of 1 March 1954 was established for detonation of the first shot.

(1) The original shot schedule, probable yield and presumed range of yield in megaton, was:

SHOT	PROBABLE YIELD	PRESUMED RANGE OF YIELD	DETONATION DATE
(BRAVO)	6	4 - 8	1 March 1954
(UNION)	5 - 10	1 - 18	11 March 1954
(YANKEE) (Later revised to with yield 9.5 and range of 7.5 - 11.5)	8	6 - 10	22 March 1954
(ECHO)	.125	.065 - .275	29 March 1954
(NECTAR)	2 - 3	1 - 5	8 April 1954
(ROMEO)	4	1.5 - 7	15 April 1954
(KOON)	1	0.3 - 2.5	22 April 1954

(2) Because of adverse weather, the effects of BRAVO and

deficiencies disclosed in KOON and ECHO, actual yields (in megatons), shot locations, detonation dates and local times were as follows:

SHOT	ACTUAL YIELD	SHOT SITE	DETONATION DATE	LOCAL TIME
BRAVO	15 ± 0.5	Land surface near Namu, Bikini	1 March 1954	0645
ROMEO	11 ± 0.5	Barge in BRAVO crater, Bikini	27 March 1954	0630
KOON	0.11 ± 0.02	Land Surface, Eninman, Bikini	7 April 1954	0620
UNION	7.0 ± 0.5	Barge off Yurochi, Bikini	26 April 1954	0610
YANKEE	13.5 ± 1.5	Barge off Yurochi, Bikini	5 May 1954	0610
NECTAR	1.7 ± 0.3	Barge MIKE crater off Teiteripuchi, Eniwetok	14 May 1954	0620

c. On-site Operations

(1) The on-site phase of CASTLE commenced with the establishment of command posts in the forward area on 17 January 1954. Arrival of major components in the forward area was phased to coincide with the immediate operational needs. By 1 February 1954 all task force elements had arrived in the forward area and preparations were begun for the conduct of the full scale rehearsal. Extensive preliminary communications checks were made and on 23 February the rehearsal for the first shot was successfully carried out. This was the only full scale rehearsal conducted. Since all shots were statically detonated and operations were similar, each detonation served as a rehearsal for the one to follow.

d. BRAVO was detonated on 1 March 1954. Prior to this shot all personnel were evacuated from Bikini Atoll, except for a small firing party which remained in a bunker on NAN (Enyu Island), approximately twenty miles

from zero point. At the time of the detonation all task force ships in the Bikini area were located southeast of the atoll at least thirty miles from zero point. After the shot it became necessary to close the camps on Bikini Atoll because of the radiological contamination and blast damage. Subsequent operations at Bikini were conducted principally from afloat. Because of unfavorable weather conditions at Bikini, it was not until 27 March that ROMEO was detonated. The concept of the shot schedule was reviewed and revised to incorporate more flexibility. NECTAR was rescheduled to be fired at Eniwetok Atoll. On 7 April, KOON was detonated at Bikini, on Eninman Island. Because of the poor results of KOON, ECHO was cancelled. At about the same time, the original YANKEE was cancelled and a modified version of ROMEO was added as YANKEE . On 22 April, the task force was capable of detonating either NECTAR at Eniwetok Atoll or UNION at Bikini Atoll. This was the first instance of such flexibility in U. S. testing history. However, weather conditions were unfavorable, and it was not until 26 April that UNION was detonated. Preparations for firing YANKEE at Bikini were completed while awaiting favorable weather at Eniwetok to fire NECTAR. By 5 May, YANKEE was readied and detonated. On 14 May, the Eniwetok weather became favorable and NECTAR was detonated. Except for rollup and redeployment, the on-site phase was essentially completed with the last shot.

e. As tasks were completed, units of the task force were redeployed and individuals were returned to parent organizations or were reassigned. In accordance with previously prepared plans, reduced planning staffs and certain troop elements were reformed as components of the task force in order to provide for continuity of operations, and for economical, expeditious support of future operations.

f. As in previous operations, weather was a major problem, particularly with regard to winds aloft for fall-out considerations. Delays were experienced because of unacceptable fall-out patterns. The tests were carried out during a period of the year when the weather in the Marshall Islands area was reasonably favorable; it was not an unusual season from a climatological point of view. Future tests must expect similar delays due to weather unless flexible firing techniques such as firing on barges in the open ocean or air drops are developed which will minimize the amount and the activity of fall-out.

g. Radiological Safety

(1) Since six shots in the megaton range were scheduled for the operation, the Radsafe Plan placed particular emphasis on the possibility of fall-out on populated islands and transient shipping. Forecasting radioactive fall-out for CASTLE was initially seriously handicapped by the absence of definitive data on the effects of very high yield (megaton) devices. Information from Operation IVY (MIKE Shot) was extremely limited and as a consequence misleading in many respects. In particular, early CASTLE experience indicated that fall-out periods on the order of six to twelve hours while adequate for yields obtained prior to IVY, were inadequate for CASTLE. It was apparent that pre-shot forecasts would be required of wind conditions for periods up to H plus 18 to H plus 24 hours with a high degree of accuracy in order to insure that the significant fall-out would take place in acceptable areas during this period of time. Generally, this requirement involved the forecasting of the stability of wind patterns, or the expected limits on the variation of the pattern during the period of fall-out. Further, it required wind forecasting for several different times and many geographical positions throughout the projected fall-out area in order to support a new

dynamic fall-out plot technique developed on CASTLE. This technique employed the concept of a 24-hour period of fall-out and considered the effects of time and cloud displacement factors on wind systems within approximately 500 miles of the shot site.

(2) Aerial cloud tracking flights were used as the primary means of obtaining a rapid evaluation of the relation between forecast and actual atomic cloud travel. Additional precision aerial surveys of land masses in the Marshall Islands were supported for studies being conducted by the New York Operations Office, AEC (NYKOPO). These two types of flights, together with a network of (NYKOPO) ground monitoring stations, were used to considerable mutual and timely advantage by the task force and the NYKOPO representatives in evaluating the fall-out patterns on populated islands and, by the task force, in advising appropriate headquarters sharing responsibilities for these areas.

(3) The maintenance of personnel radiation exposures at the lowest possible level was the third major task force Radsafe problem. The planned Maximum Permissible Exposure (MPE) of personnel was 3.9 roentgens. However, it was anticipated that this limit would be too low considering the number and expected yields of the weapons and devices to be tested. Consequently, the Radsafe Plan, with the concurrence of the Surgeons General of the three Services and the Director, Division of Biology and Medicine, AEC, included provision for waiver of the MPE by the task force commander in individually designated cases when circumstances indicated the need and justification therefor. This authority, exercised for a relatively few number of individuals, was adequate for the completion of essential CASTLE missions. Except for relatively high accidental exposures on 28 personnel at the task force weather station on Rongerik Atoll, and a small number of

other individual cases, none of the task force personnel received doses in excess of 7.8 roentgens. In fact, less than 8% of the task force personnel received a total exposure in excess of the established MPE of 3.9 roentgens, and less than 2% in excess of 6.0 roentgens.

(4) Specific details pertaining to each CASTLE shot: As a general rule, the winds in the Marshall Islands area are east northeasterly to easterly in the lower, or tradewind, levels (up to about 20,000 feet), and easterly in the high levels (above tropopause height, or about 60,000 feet. In the general discussion of wind patterns for each shot below, the mid-levels winds (20,000 to 60,000 feet) are the primary consideration, since they are not only variable, but also involve the most significant portion of the cloud from a fall-out viewpoint.

(a) BRAVO

1. The BRAVO mid-level winds were from west southwest. The trades were shallow (approximately 5,000 feet) with light northwesterlies to westerlies to 20,000 feet and the high winds were more east northeasterly than easterly.

2. BRAVO was detonated as a land surface shot on a small sand spit near NAMU (CHARLIE) at Bikini

3. The task force fleet was at least 30 miles southeast of ground zero at H-hour, and steamed further south upon receiving early fall-out.

4. Close-in ground contamination on the shot atoll was high, and spread in a somewhat uniform elliptical pattern to the east. At H plus 4 hours, the airstrip on AIRUKIJI (OBOE) was reading 10.5 r/hr; the ENYU (NAN) camp approximately 2.5 r/hr at 125 feet and the DOG-GEORGE chain from 3 to 50 r/hr at 100 feet.

5. The yield of BRAVO was three times the most probable predicted value and twice the predicted upper limit. Consequently, more radioactive debris was carried up and diffused over a much larger area than was expected. BRAVO demonstrated that the origin of the fall-out pattern is a large area up to 25 miles in radius, varying according to the yield. Radioactive intensities at specified distances, likewise, varies with the yield.

6. BRAVO produced high contamination on populated areas immediately to the east of the test site which necessitated the evacuation of groups of Marshall Islands natives and certain U. S. military personnel. Elements of the task force fleet and personnel were involved in early fall-out which necessitated full use of naval atomic countermeasures and retirement of the fleet to regions more distant from ground zero. The incidents associated with this shot resulted primarily from the lack of fall-out information from previous shots of comparable yield, the unexpectedly high yield of BRAVO and an average deviation of approximately ten degrees (in an adverse direction) between the observed and forecast winds for shot time. The net result was an aggravation of the adverse conditions ordinarily predictable and acceptable under operational criteria and forecasting techniques in existence prior to the BRAVO event.

7. All CASTLE shots subsequent to BRAVO were detonated without significant fall-out impact. This was due to complete analyses of the effects of BRAVO, the application of this information in the development of realistic and dependable fall-out forecasting techniques and the development of better limiting wind pattern criteria within which the fall-out pattern could safely lie.

8. 82 natives of Rongelap Atoll and 154 natives of Utirik were evacuated to Kwajalein Atoll as a result of the fall-out from

BRAVO. Some of the Rongelap natives received total exposures in excess of 100 roentgens. No fatalities or known significant after-effects resulted. The Utirik natives received approximately 17 roentgens. The report on the care and treatment of the natives will be presented in detail in the final report of the military effects tests programs.

9. The Utirik natives were returned to their homes in May 1954. The Rongelap natives were moved to Majuro Atoll in June 1954 to occupy a new temporary village constructed with task force facilities, materials and funds. Additional task force funds will be furnished, as necessary, to reimburse the Trust Territories for necessary native living costs while housed at Majuro.

10. It is estimated that Rongelap Atoll will be safe for native re-occupancy by about 1 May 1955. In the interim, quarterly inspection trips will be made to Rongelap Atoll by special survey parties to determine the progressive contamination status and the exact date of return of the natives.

11. One Japanese fishing vessel was contaminated in an area reported by the Japanese to be approximately 80 to 90 miles east northeast of Bikini. The reported position of this vessel was within the pattern of the search aircraft on shot day. Failure to contact the Japanese vessel was due to severe aerial contamination of the search aircraft when approximately within radar range of the ship. The replacement search aircraft, directed to pick up and complete the search pattern, was unable to sweep the close-in area missed by the original aircraft due to the same radiological difficulty.

12. Detailed information on the evacuation and rehabilitation of the Marshall Island natives and the Japanese fishing vessel incident

is contained in Tab H.

13. Detailed radsafe information, and pertinent weather factors, are presented in Tab K.

(b) ROMEO

1. ROMEO mid-level winds were southerly except that the tops of those levels (50,000 to 60,000 feet) were westerly at shot time, becoming southerly by H plus 2 hours. The tradewinds were easterly at shot time with a layer of southerlies between 6,000 and 12,000 feet. The entire tradewind level to 20,000 feet shifted to east southeasterly by H plus 2 hours.

2. ROMEO was fired from a barge at BRAVO GZ in water approximately 110 feet deep, the first water surface shot in the history of U. S. atomic testing.

3. The task force fleet was located approximately 30 miles southeast of ground zero.

4. Close-in ground contamination from ROMEO was limited to a radius of approximately 10 miles, the values being somewhat less than for BRAVO.

5. Lagoon contamination from ROMEO was limited essentially to a drift of radioactivity toward the south along the western reefs, flushing slowly out the western channels.

6. No significant health hazard resulted from ROMEO, either to units of the task force or to populated islands in the vicinity, although appreciable (but not hazardous) contamination was deposited on Rongelap and Rongerik.

7. Preliminary reports from Project 2.5a (Fall-out Distribution) indicated that the aerosol-type cloud from ROMEO tended to resist fall-out off the shot atoll for at least 50 miles downwind but that

it deposited intensities comparable to BRAVO on objects exposed broadside to the cloud drift.

8. The long-range ROMEO cloud persisted for a considerable time, apparently transiting Rongelap and Rongerik Atolls on plus one day. Effects of the cloud were also recorded at Bikini at about H plus 42 hours and at Eniwetok at about H plus 54 hours. Intensities at Bikini reached values of 15 to 84 mr/hr. Intensities at Eniwetok ranged from about 5 to 15 mr/hr; Kwajalein recorded 1 to 9 mr/hr at about the same time.

9. To evaluate the effects of the tradewinds on Eniwetok, one additional cloud tracker was placed to the west of ground zero at 5,000 feet to augment the routine tracker at 10,000 feet. Aerial intensities in the roentgen range were detected to the north of an east-west line between Bikini and Eniwetok. Eniwetok was especially alerted to this fact; however, all contamination passed to the north. The general results of ROMEO, and other water surface shots, indicate that, had the contamination passed over Eniwetok, much of the intensity values would have resulted from a "shine effect".

10. Detailed radsafe information, and pertinent weather factors are presented in Tab L.

(c) KOON

1. KOON mid-level winds were southerly to southeasterly, becoming southerly to 25,000 and west southwesterly to 60,000 feet by H plus 3 hours. The tradewinds were very shallow, averaging about 2,000 to 4,000 feet in depth during the first three hours after the shot.

2. KOON was a land surface shot detonated on the western tip of ENINMAN (TARE) at Bikini.

3. The task force fleet was located approximately 25 miles east of ground zero for operational reasons, with instructions to steam south after H-hour.

4. Due to the unexpected low yield of KOON, no significant contamination problems arose. Close-in contamination was limited essentially to the shot island, the island immediately to the west of ground zero, the anchorages just off the shot island, and across the lagoon on the DOG-GEORGE chain and BIKINI (HOW) Islands.

5. At shot time, a large rainstorm was present between ground zero and the task force fleet. No radiological damage resulted to the fleet due to sufficient distance between the ships and the storm.

6. A small amount of contamination was deposited on Rongelap and Rongerik from KOON. This was believed to be due to either rain-out from approximately the 25,000 foot levels, or due to a relatively efficient transport of most of the debris to the east and subsequent subsidence and scavenging by rain showers known to be in the general area.

7. Detailed radsafe information, and pertinent weather factors, are presented in Tab M.

(d) UNION

1. UNION mid-level winds were west southwest. The trade-winds were light and shallow (about 10,000 feet in depth), and light and variable between 10,000 and 14,000 feet. Light westerlies existed from 14,000 to 20,000 feet.

2. UNION was a barge (water surface) shot in the lagoon (in approximately 120 feet of water) near YUROCHI(DOG) at Bikini.

3. The larger ships of task force fleet were located approximately 30 miles east southeast of ground zero for operational reasons.

but were instructed to steam south immediately after H-hour. Smaller ships were located further, and more southeasterly, from ground zero at H-hour.

4. Due to the predicted upper limit on yield for this shot, the ROMEO fall-out experience was used with considerable caution in the UNION Radsafe plan. Subsequent events, however, indicated characteristics quite similar to ROMEO, i.e. aerosol-type cloud. Contamination from the mid-levels was not instrumented.

5. Long-range contamination from UNION was slight in comparison with ROMEO, probably due to more favorable winds in these levels to the east of ground zero.

6. The dynamic system of fall-out plotting developed on CASTLE was first used for this shot, and continued for all subsequent shots.

7. Detailed radsafe information and pertinent weather factors are presented in Tab N.

(e) YANKEE

1. YANKEE mid-level winds were southwest to west southwest. Tradewinds were shallow (10,000 feet deep) with light northerly to northwesterlies between 10,000 and 20,000 feet.

2. YANKEE was a barge (water surface) shot in the lagoon (in approximately 120 feet of water) near YUROCHI (DOG) at Bikini.

3. The larger ships of the task force fleet were located approximately 30 miles east southeast of ground zero for operational reasons, but were instructed to steam south immediately after H-hour. Smaller ships were located further, and more southerly, from ground zero at H-hour.

4. Although YANKEE winds were somewhat less favorable than UNION (lower level winds veering around counter-clockwise), ROMEO and UNION experience were such that this factor could reasonably be accepted.

Post-shot experience indicated reasonable agreement with the forecast except that the southern islands were not appreciably contaminated from this shot. The bulk of the contamination expereienced was confined to the northern and eastern islands, including NAN.

5. YANKEE characteristics were completely within the experience of ROMEO and UNION. Appreciable air intensities were measured over NAN and TARE and in the general vicinity of Rongelap, however, no appreciable ground deposition was associated with these observations.

6. The ocean fall-out pattern was roughly delineated for this shot by the AEC's New York Operations Office program (using aerial surveys of styrofoam rafts and the water itself) and by Project 2.5a, (using surface water sampling techniques). In addition to the documentation of YANKEE, this work was extremely useful in organising the plan used by these two groups on the last shot (NECTAR).

7. Long-range contamination from YANKEE was slight at Rongelap in comparison with ROMEO, and, although aerial intensities in the vicinity north of Bikar were measured in the roentgen range as late as H plus 20 hours, no significant increase in the ground readings (extrapolated from aerial survey at about H plus 36 hours) were noted at this atoll.

8. One isolated incident of interest involved two LST's (one with wash-down equipment, the other without special gear) enroute (in company) to Pearl, at approximately 700 nautical miles east northeast of ground zero. These ships observed intensities of 40 and 96 mr/hr maximums for the wash-down and non-washdown ships respectively. Contamination started at H plus 31 hours and continued until H plus 42 hours. Atomic counter-measures taken by the LST's reduced intensities to approximately 8 to 10 mr/hr maximums. It is conjectured that an appreciable portion of the observations

by these ships was due to a "shine" effect from the YANKEE cloud.

9. Detailed radsafe information and pertinent weather factors are presented in Tab O.

(f) NECTAR

1. NECTAR mid-level winds were southwesterly to south southwesterly to 45,000 feet and westerly to 60,000 feet. The tradewinds were east southeasterly to 20,000 feet.

2. NECTAR was a barge (water surface) shot in the IVY MIKE crater (approximately 100 feet of water) off Teiteripuchi at Eniwetok.

3. The task force fleet was south of the atoll at shot time and re-entered after H-hour for an emergency evacuation capability.

4. No significant radiological problems arose from this shot. Close-in contamination was limited essentially to the islands north of YVONNE.

5. Extensive weather (cloud cover and rain) preceded the NECTAR shot. At H-hour a large rainstorm was over the lagoon between ground zero and the southern islands; however, ground zero and the northern islands were relatively clear below the bases of the low weather clouds (i.e. clear from the surface up to about 2,000 feet).

6. Weather and clouds extending in layers up to about 50,000 feet persisted for at least the first six hours after shot time.

7. Moderate continuous rain occurred throughout the shot day. All of the weather observed on shot day was attributable to the prevailing general weather situation, primarily the strong southerly wind flow.

8. A unique feather of the NECTAR Radsafe plan was the stationing of a destroyer at Ujelang in the event an evacuation of that atoll

became necessary. Since cloud tracking efforts at 5,000 and 10,000 feet southwest of Eniwetok through H plus 6 hours indicated no concern for Ujelang, the destroyer was ordered to return to base.

9. A considerable effort was made by the AEC New York Operations Office fall-out program and Project 2.5a to document the NECTAR fall-out pattern along the lines of similar work done on YANKEE.

10. Detailed radsafe information and pertinent weather factors are presented in Tab P.

PART TWO: RADIOLOGICAL SAFETY PROBLEMS

1. Originally, Operation CASTLE involved four events in the very high yield range. As plans progressed, the schedule was increased to seven events, and then reduced during the operation to six. As a consequence, the Radsafe Plan for the operation required detailed re-evaluation to determine the practicality of various assumptions and planning factors. Primarily, since each extra event (insofar as personnel radiation dosages were concerned) was additive, the permissible exposure per event for shot participants decreased as the number of events increased. Prior to Operation CASTLE, the maximum number of events at the Pacific Proving Ground (PPG) was four on Operation GREENHOUSE. The maximum number of high yield events was two on Operation IVY, of which one was an air burst at 1,500 feet. It appeared that CASTLE planning would have to be built around the same personnel dosage allowance as used on these operations regardless of the number and yields of the events for CASTLE. There was an obvious need for ways and means to cut down on personnel exposures per shot or to raise the permissible dose for some individuals.

a. In regard to efforts to cut down on personnel exposures, a number of factors were involved. Not all personnel would participate in each event; however, it appeared to be a logical assumption that the average number of events for participation would increase. It was also assumed that the total number of people involved in the operation would increase due to attempts to spread the permissible dosage over a sufficient number of participants to effect an over-all average dose within acceptable limits. It was also clear that some form of indoctrination was necessary in order to effect completion of work in contaminated areas with the maximum efficiency in order that the

acquired dose represented maximum conservation of personnel exposures. The individuals primarily involved in this problem were expected to be the scientific project participants. Consequently, a special course of instruction was devised for the Radsafe monitors of the various projects. This course of instruction stressed the practical applications and field expedients involved in the monitor's work. The MPE of 3.9r for the operation was stressed in its relation to realistic planning by the projects. The basic problem was the relation between the numbers of people capable of doing project work (including Radsafe monitors) and the burn-out rate of the project recovery teams. These factors depended upon the number and type of shots in which the project participated, proximity of recovery stations to ground zero, problems of locating instrument sites after water wave and blast-induced topographical changes, complexity of instrument site, expected time required to re-enter the instrument site plus a factor of safety to cover expected damage to doors or time to clear away coral or debris from doors. Since the project people had only 3.9r to spend for their entire participation, it was emphasized that they should make realistic plans to pass the recovery job around to all members of the project party and to avoid having an "indispensable man" who alone was capable of cocking an instrument or removing a record. It was pointed out that a critical problem would arise from burn-out of key project people and their intense desire, shot after shot, to be the only ones to touch their instruments and records. The course stressed that the provision for CJTF SEVEN waiver of the 3.9r MPE (para 1.b. below) would be used only as a last-ditch measure and would require full justification and evidence of realistic pre-operational planning. Monitors were requested to use IVY MIKE shot contamination data, the number of shots on which each member would participate, the expected hours/day and time required to recover records from which a reasonable

recovery plan could be devised.

b. In recognition of the mutually exclusive aspects of a fixed MPE for the entire operation and the greater amount of work to be accomplished in contaminated areas, it was obvious that some form of relaxation of rigid dose limits was necessary. Several methods of relaxation of the MPE were apparent. There was the possibility of assigning the MPE of 3.95 to calendar quarters and thus take advantage of the fact that Operation CASTLE extended over two such quarters, giving a total of 7.8r for the first six months of 1954. Some U. S. laboratories and industries now use this system. The primary AEC objection to such a generalized solution lies in the fact that, whereas on a field test, dosage limits must be flexible enough to allow limits set without regard to the rate of acquisition, such is not the case in laboratories. In the latter case, control features are set up on a week-by-week, year-by-year basis to limit exposures to 0.3r per week, and to remove from radiation work those personnel exposed in excess of a maximum averaged progressively on the basis of 0.3r per week. Similarly, a flat MPE of, for example, 7.8r for the operation was objectionable to the AEC for similar reasons and because of a general lack of long-term radiation effects information on year-by-year acquisition of dosages at even the currently acceptable rate of 0.3r per week. The most promising avenue of relaxation appeared to be some sort of waiver provision to be exercised by the Task Force Commander in exceptional cases where the technical import and the medical aspects of proposed work could be evaluated before the fact in conjunction with the necessity for completion of specific missions. Provision for waiver of the MPE was built into the CASTLE plan (Tab A and Tab B) with the concurrence of the Surgeons General of the three Services and the Director, Division of Biology and Medicine, AEC. The waiver provision was used to an appreciable

extent to resolve special cases, the majority of which were a number of scientific project personnel and the crews on four major ships. The various factors involved were weighed and evaluated in all cases, the technical and medical implications and the ability and necessity for completion of missions were the major factors leading to the decisions to authorize a departure from the 3.9r standard for the operation.

2. Shot Conditions and General Results: The following discussion is limited to shot locations, generalized indication of yield, planning assumptions and general results of the CASTLE shots. Detailed shot results are presented in Tabs K through P.

a. The CASTLE program included shot conditions not previously encountered in test operations, i.e. shots on barges in relatively shallow water, and one shot on a small sand spit. According to the latest schedule prior to the operation, the shots at Bikini Atoll would be located - one on a small sand spit in the vicinity of NAMU, four on barges in the lagoon near YUROCHI and one on ENINMAN. One shot was scheduled for EBERIRU on ENIWETOK. All shots were to be surface events, statically detonated. All shots were in the very high yield range except the one at ENIWETOK. As executed on CASTLE, one of the four BIKINI barge shots was moved to a barge shot in the IVY MIKE crater at ENIWETOK, and the EBERIRU shot was cancelled.

b. The IVY MIKE shot radiological fall-out data illustrated a somewhat new feature in the fall-out phenomena associated with the detonation of high yield weapons. Stated in its simplest terms, and insofar as the atoll islands are concerned, there was little difference between upwind and downwind conditions for a considerable distance from ground zero. This phenomena was ascribed to a terroidal atmospheric circulation set up locally and from which the heavier bomb and bomb site debris was force-fed to the ground by

the circulating winds. As a consequence, the up-wind or cross-wind distances become critical, the lateral spread of the early fall-out being such that relatively high radiation intensities can occur in these directions. For Operation CASTLE, it was assumed that the problems raised by this phenomena would most likely occur at BIKINI. This atoll, being relatively narrow along the north-south axis, with ground zeros along the northern reef, and camp sites on the south (ENINMAN and ENYU), was assumed to be particularly susceptible to the cross-wind and up-wind fall-out. It was assumed that with detonations along the northern reef, with yields on the order of MIKE and fired under the ground zero conditions of MIKE, fall-out on the ENINMAN camp could be expected to reach a maximum of 1.0 to 10.0 roentgens per hour within about two to three hours after H-hour. This could mean a delay of from one to two weeks in putting the ENINMAN camp back into full time operation. Conditions on ENYU were assumed to be considerably better due to the greater distances from zero points and its relatively up-wind position. For the shots involved, the reef shot southwest of NAMU and the barge shots in the vicinity of YUROCHI, it was expected that the NAMU shot should give the most trouble since its firing conditions would vary nearly approximate those of MIKE. Here the conditions for heavy fall-out, namely the u-take of a large quantity of coral (to which the radioactive particles could condense), would be such that the coral particle scavenging action should be as efficient as MIKE, resulting in considerable fall-out in the atoll area cross-wind and up-wind. Since the barge shots were to be fired in water of a depth approximately that of the MIKE crater, it was expected that little coral or bottom material would be taken up into the "hot" cloud. Consequently, the scavenging action in the atoll region was expected to be greatly lessened. It should also be noted that the conditions for a highly radioactive base surge would

not be present for the barge shots. At Bikini BAKER, the water causing the base surge was part of the blast and fireball, having been carried up along with and mixed with the highly radioactive particles. For the barge shots, any water raised should be that which is sucked up into the relatively cool cloud stem. Past experience, particularly with dust drawn up in tower shots in Nevada, has shown little radioactivity to be present in the resulting material which returns to the surface from the lower cloud stem. Although it seemed probable that a phenomena would occur on the barge shots which would have the appearance of a base surge (due to large quantities of water falling back into the lagoon), it was not expected that appreciable radiation would be transported in this fashion as was the case at Bikini BAKER. Summarizing, it seemed that the local contamination problem was most urgent for the NAMU shot, and considerably less urgent for the barge shots. In this respect, the ground zeros were favorable, the NAMU shot being most distant from the closest camp site (ENINMAN), and the barge shots closer, but less likely to highly contaminate the camp. It was considered that the chances were more against, than for, high radioactive contamination of the camp sites.

c. It was recommended that personnel of the ENINMAN camp site be evacuated (less those persons indicated in d below) for the NAMU and the barge shots. At H plus three to four hours Radsafe survey work would allow a positive determination of whether or not high contamination levels existed, or would exist, at the camp sites. In the event of contamination at the camp site, knowledge of the decay characteristics of the radioactive fall-out would be such that an accurate prediction could be made for a favorable re-entry time. Under the worst condition, task force personnel would be required to spend about 24 hours for either "cooling off" of the camp site or for a return trip to Eniwetok in the event extended "cooling off" time was necessary.

This evacuation could be on an austere basis utilizing existing ships in the area and with a "standing room only" philosophy.

d. At one time it appeared that it might become necessary or desirable to leave small numbers of emergency and utility personnel at the ENINMAN site during the NAMU and barge shots. In this event it was recommended that the plan include only a few people (on the order of two or three helicopter loads) to remain where their presence was necessary to man instrument sites, camp utilities or airstrip emergency equipment. Should it become necessary, this small number of people could be drawn off rapidly enough to prevent accumulation of high exposures. Although it was recognized that even large numbers could be evacuated within a reasonable length of time and with perhaps only mild over-exposures, such an evantuality could conceivably hamper future operations by using up for a large number of personnel on one shot most, if not all or more, of the authorized radiation exposures for the entire operation.

e. As the shots progressed it became more and more apparent that the planning assumptions were justified. Except for the yield of BRAVO (which effectively aggravated and exaggerated all the adverse features in the existing wind structure) the assumptions were sufficiently valid to predict the end result with a fair degree of accuracy. As a general statement BRAVO behaved to a great extent like a highly contaminating surface burst over a wide plane of earth. The great amount of solid material carried up into the column and mushroom returned to the ground forming roughly a circular isodose line pattern on the shot atoll. Long range down-wind, this shot produced intensities much higher than hitherto seen or expected in test operations to distances up to 300 miles over a period of approximately 12 to 18 hours. Contamination of the ENYU and ENINMAN camp sites was predicted from the BRAVO wind pattern, although

resultant intensities, particularly on ENYU, were higher than anticipated. The barge shots, on the other hand, appeared to remain in a fine aerosol-type cloud (without a base surge phenomena) persisting for long periods of time. Close-in on the shot atoll, the barge shots produced contamination comparable to BRAVO. Long range aspects indicated high aerial intensities out to at least 50 miles and appreciable (but not dangerous) intensities out to 600 miles for periods of 24 to 48 hours after the detonation. This latter feature of the barge shot raised a crucial problem which should be considered on future operations, namely the necessity of evaluating the "shine dose" from this type burst in particular, and high yield shots in general. (See para 4.d).

3. The development of the CASTLE Radsafe Plan revolved primarily around two basic criteria, i.e. the so-called Rule Dose and the Tactical Dose.

a. Rule Dose: This dosage allowance is the legal limit or Maximum Permissible Exposure (MPE) of 0.3r per week (gamma only) set by the AEC upon the advice of a committee of radiation experts. It is the industrial safeguard based on a continuous week by week, year by year exposure at this rate. Since this is the legal limit, deviation from this standard may tend to place the Task Force Commander open to question. As a consequence, the limit creates radiation control problems in each instance of work performed in contaminated areas and becomes progressively more a problem as the yield, the number of atomic events and the rapidity with which they are detonated increase.

b. Tactical Dose: This dosage allowance is that amount accepted by DOD authorities in the radiation field for use in tactical or emergency situations as required. It is based upon the consideration that it will be

received as an exception as opposed to the frequent and regular lifetime exposure rate for the Rule or Legal dose limit. It also assumes that individuals so exposed will be kept from any further exposure if at all possible. The upper limits of the tactical dose (taken over short intervals) were as follows:

(1) Less than 100r: Little effect.

(2) More than 100r: Possible deterioration (nausea and vomiting), no deaths.

(3) 200r: Some deaths might occur, rapid deterioration.

(4) 450r: Mean Lethal Dose (MLD), i.e. expectation of 50% deaths

(5) 650r: Lethal in most cases.

c. The CASTLE Radsafe Plan was necessarily designed to meet the requirements of the Rule Dose limits. Certain modifications were made in the rules as follows (with the concurrence of the Surgeons General of the three Serivces and the Director, Division of Biology and Medicine, AEC):

(1) The integrated exposure of 0.3r per week for 13 weeks (3.9r) was authorized to be taken without limitation as to the rate of exposure and without regard to the individual's radiation history provided no over-exposure remained for compensation. The 3.9r was further augmented by 0.3r per week for each week in excess of 13 weeks required for Operation CASTLE. Operation CASTLE, insofar as personnel radiation exposure was concerned, was designated to start on the first event minus 15 days for all task force personnel.

(2) The crew members of air sampling aircraft were authorized an MPE of 20r for the entire period of Operation CASTLE. All personnel so exposed were to be removed from further work in radiation until sufficient time elapsed to bring their average exposure down to 0.3r per week. It was planned

to expose these people to about one-half the authorized 20r, reserving the remainder as a contingency against radiation accidents.

(3) The Task Force Commander was authorized to revise the MPE by waiver in individually designated cases when circumstances indicated the need and justification therefor. This waiver provision applied only to the MPE of 3.9r and did not apply to the special MPE of 20r for the air sampling crew members (Tab B).

d. As stated above, the CASTLE Radsafe Plan was designed to meet the requirements of the Rule dose as modified by agreements with the authorities in the field. However, due to the special nature of field tests such as Operation CASTLE, it was assumed that a policy of strict adherence to the radiological standards prescribed for routine laboratory or industrial use was not realistic. The intent in the CASTLE plan was to strive for a reasonable and safe compromise considering conservation of personnel exposures the international import of the tests and the cost aspects of delays chargeable to excessive radiological precautions. In an effort to set up practical standards and still insure legal strength in the task force command position, the intent and spirit of the standards were interpreted in terms of "real safety" versus "rule safety". At no times, however, were recommendations made involving a "tongue-in-cheek" approach to real bodily safety of personnel. Rather the effort established criteria and evaluation for waiver of MPE to reflect reasonable conservatism in "rule safety", i.e., radiation exposure of individuals within the intent and spirit of the prescribed rules which were of primary concern to the AEC and DOD, and still be consistent with the need for completion of the CASTLE mission. The one exception to the above philosophy was the specification of the tactical dose as a guide to be used in thes-

situations involving tactical action against foreign intervention or emergency rescue operations. The specification of the tactical dose as a guide was in conformity with basic rules in such cases wherein a commander or officer-in-charge must make decisions weighing the damage probabilities and other adverse effects of the possible lines of action in tactical or emergency situations.

4. Off-site Operations:

a. By JCS decisions dated 13 April 1951 and 14 April 1953, CINCPAC was given responsibility for the safety of all stations and units of the area, other than JTF SEVEN, relative to the hazards introduced by the CASTLE Operation. By these directives, CJTF SEVEN was specifically directed to provide for the safety of personnel and units assigned to the task force. CJTF SEVEN was additionally directed to advise CINCPAC of the special hazards and danger areas involved in the tests and appropriate precautions required to insure the safety of units in the area within the purview of the Pacific Command other than JTF SEVEN.

b. As a consequence (by CINCPAC Serial 0024, subject: Security, Safety and Movement Control of Joint Task Force SEVEN During Active Phases of Operation CASTLE, dated 13 January 1954), CINCPAC directed CINCPACFLT to assume complete responsibility on safety matters for CINCPAC and to take such action as necessary to provide for the safety of all units and populated areas of the Pacific, except those attached to JTF SEVEN, incident to the hazards introduced by Operation CASTLE. In connection with this responsibilit CINCPACFLT was directed to:

(1) Take action on all advisories incident to all possible effort of CJTF SEVEN to minimize hazards to inhabitants of populated Pacific Islands.

(2) Conduct liaison with HICOMTERPACIS, CAA other military and governmental agencies and civilian authorities as appropriate.

(3) Keep CINCPAC and CNO informed of the provisions for safety to be taken in the Pacific.

(4) Exercise for CINCPAC all functions of movement control except as otherwise specified.

c. In accordance with the JCS decisions, CJTF SEVEN advised CINCPAC by letter, J-3/729.3, subject: Safety Measures During Operational Phase of CASTLE, dated 11 December 1953 (Incl 4, Tab C), of special hazards involved in the CASTLE tests and appropriate precautions required to insure safety of inhabited islands and units in the area within the purview of the Pacific Command other than JTF SEVEN. CJTF SEVEN also furnished CINCPAC by letter, J-3/300.4, subject: Schedule of Messages Concerning Detonations During CASTLE, dated 3 December 1953 (Incl 3, Tab C), a schedule of message advisories concerning CASTLE detonations in order that CINCPAC could be kept informed of developments. Although the schedule of advisories was originally set up for CINCPAC as action addressee, a later change (in accordance with 4.b above) provided for CINCPACFLT as action addressee with CINCPAC, COMHAWSEAFRON and COMNAVMARIANAS as information addressees. In addition to the above, an exchange of correspondence between CJTF SEVEN and CINCPACFLT discussed in considerable detail the specific feathres of the task force plan for mutual discharge of JTF SEVEN/CINCPAC responsibilities under the JCS directive. Since the above correspondence contains the basic thoughts behind the overall off-site Radsafe Plan, the letters and wires involved have been attached in Tab C for record purposes.

d. In general, the radsafe off-site operations were carried out as

planned and were adequate for the CASTLE tests. As the operation progressed, however, certain modifications were made as dictated by unusual circumstances which arose. These modifications are discussed below.

(1) Native populations: As indicated in the native populations chart (Tab G), the bulk of the indigenes within 500 NM of GZ reside in the southeast quadrant. Consequently, all atolls except UJELANG (and ENIWETOK for BIKINI shots) were considered to be in a favorable location with respect to fall-out. However, as indicated in Tabs K through P pertaining to each event, there was a general movement of air particle trajectories to the east regardless of the initial directions of the winds near ground zeros. This phenomena was associated with all shots, the mid-level air particle trajectories turning toward the east as the cloud moved away from GZ, even to the point of taking place from positions relatively close to ground zero on the two shots (ROMEO and NECTAR) with pronounced southerly flow at ground zero. The net consequence of this action was the eventual transport of the most significant portion of the cloud (i.e., the mid-levels from approximately 20,000 feet to 60,000 feet) to the east where subsequent subsidence of the debris could place a considerable amount in the trade wind flow to be brought back into the general area of the tests. The gross effect of this mechanism (as well as other factors) was profoundly indicated on the BRAVO shot. Its effect was apparent to a much lesser degree on the remaining shots. The diminished contamination of the remaining shots appears chargeable to more favorable initial wind conditions, the low yield of the one remaining land surface shot (KOON), and to the fact that all subsequent high yield devices were shot from barges. The pertinent facts and ideas which became apparent as the shot schedule progressed, and due to the phenomena described above, are as follows:

(a) The native atolls in the southeast quadrant, particularly those in the northern portion of the quadrant, were in a less favorable position for high yields than previously supposed, the degree of favorability depending upon the yield, initial wind conditions, shot site (barge, land, air) conditions, and the proximity of the air particle trajectories to a west-east line.

(b) Shot decisions should be reached only after considering the impact of an air particle trajectory analysis over a period of time and space sufficient for significant fall-out to occur. Initially, CASTLE planning factors in this regard were twenty-four hours and 500 nautical miles as the upper limits beyond which no significant hazard should exist. For the hazardous phase of fall-out, the significant portion considered was the RADEX plot (using ground zero winds) and the forecast air particle trajectories for the first twelve hours. Subsequent to BRAVO the RADEX was augmented by a new technique developed to plot the fall-out pattern over a period of twenty-four hours using the forecast air particle trajectory analysis revised progressivel as the forecast cloud segments moved out of the vicinity of ground zero (See Tab D).

(c) Of the contamination arriving at the native atolls in the southeast quadrant, some fell on the islands, whereas some undoubtedly remained in the moving air mass passing over the islands. This phenomena appeared, from various observations, to be more persistent in time and space for barge shots than for land shots.

(d) Since the mean free path of gamma in air is something on the order of 2,000 feet, an appreciable slice of the air mass is involved in "shining" on the islands. This contribution, estimated to account for as much as 50 percent of the dose rate experienced by the inhabitants during

the cloud transit, was not measured on any of the native atolls, but was observed following ROMEO during light secondary fall-out at BIKINI.

(e) Although the deposition of radioactive matter on native atolls from each shot subsequent to BRAVO was relatively insignificant, continuous additions of small amounts of contamination can eventually build up an appreciable background of long-lived fission products. This conceivably could result in prohibitive levels causing cessation of testing or permanent removal of native inhabitants.

(f) Provision should be made on future operations to measure the effects of radiation "shine" on at least the inhabited northern Marshall Islands Atolls. Also, to record the total dose for the operation, or for a particular event, a representative number of film badges should be cached, or worn by responsible personnel on these atolls. In order to maintain standard conditions of dosimetry, task force film badges and task force processing of the badges should be used.

(g) In order to avoid delay in determining the occurrence of fall-out on native atolls, and to implement paragraph 4.d(1)(f) above, manned monitor stations should be maintained on at least the northern Marshall Islands Atolls. These monitors should be equipped with two-way radio communications facilities, preferably of the CW-type for reliability and low power requirements.

(2) Cloud trajectories and interference with air routes: Definitive data on this subject were passed to CINCPACFLT in terms of specific recommendations against closure of routes or to close a specified route for a specified period of time. Forecast trajectories were given in terms of the geographical coordinates of the 24, 48 and 72-hour forecast positions

of each level involved. Normally the levels covered were in ten thousand feet increments; however, not every such level was given. Rather the attempt was to cover those levels of interest up to about fifty to sixty thousand feet, presenting the levels having a unique or significant orientation, or those levels which bounded, or most nearly represented, the drift of the main portion of the cloud. Although trajectories for significant levels were passed to CINCPACFLT (and revised if necessary) the decisions as to the effect of each situation also included consideration of the following factors:

(a) Flight levels within the first 20,000 feet were considered of primary concern.

(b) The orientation of levels above 20,000 feet (from which contamination could fall into the lower level) were evaluated in terms of time and geographical position of settling of contamination into normal flight levels.

(c) Recommended closure times and altitudes included estimated flight times between possible departure points and the forecast positions of contamination.

(d) Forecast trajectory position beyond twenty-four hours were considered to represent positions of insignificant contamination.

(e) Cloud tracking operations post-shot were analyzed for possible impact on the pre-shot decision.

(3) Protection of transient shipping: In order to provide protection for transient shipping in the region immediately outside the ENIWETOK-BIKINI Danger Area, planning factors were established and a plan of action placed in effect as follows:

(a) CASTLE clouds more than twenty-four hours old were not

assumed to be hazardous. Twenty-four hours travel of a CASTLE cloud was assumed to be approximately 500 nautical miles.

(b) CINCPACFLT was requested to make advance diversions of shipping outside a sector area from southwest clockwise through north to east, to 500 nautical miles from ground zero from H to H plus 24 hours. This was accomplished on all shots; however, since the control involved primarily only U. S. shipping, arrangements were made subsequent to BRAVO to effect maximum coordination with other nationalities. Also, the excluded area was changed to an officially designated Danger Area subsequent to BRAVO and re-defined as the sector area centered on 12° N, 164° E, from 240° clockwise to 95°, radial distance 450 nautical miles. Within this sector an additional area designated Area GREEN was defined as the region bounded by 10° 15' N, 16° 40' N, 160° 10' E, and 170° 20' E. (The significance of Area GREEN is discussed in 4.d(3)(c) below.) A further modification subsequent to BRAVO provided for all U. S. shipping passing within 600 nautical miles of BIKINI to come under the operational control of CTG 7.3 (for radsafe diversion if necessary) while within this limit.

(c) P2V aircraft were planned to sweep the significant forecast sector of fall-out, using visual and search radar methods of sightings out to 800 nautical miles on D minus 2 days, out to 600 miles on D minus 1 day and, if necessary, in front of the cloud on D Day. Since the reliable range of the P2V search radar was taken as thirty to fifty NM, the effective width of the sweep of a single P2V was (roung trip) 120 to 200 NM. The P2V aircraft crews were instructed to report the presence of any shipping sighted on D minus 2 day sweeps and to attempt to effect the diversion of all ships sighted on D minus 1 day and D Day. Although this plan was used on Operation

IVY with success, its serious limitations were not apparent until the BRAVO shot. On Operation IVY the fortunate circumstance of the absence of any shipping in the actual fall-out area was not repeated on the BRAVO shot. Further, the 120 to 200 NM strip within the search capability of a single P2V aircraft was found not commensurate with the variations which could occur in the forecast winds from D minus 2 days forward through shot time. More than one P2V aircraft making parallel sweeps, although a somewhat better solution, was still not the answer. The dominant fact that became apparent was that a large area was involved in order to be assured of covering the variation in the forecast winds, the diffusion of the cloud along its path of travel, and changes in direction of drift of the cloud at points outside the influence of ground zero winds. For this reason, subsequent to BRAVO, the search plan was modified to intensively search Area GREEN (defined above) with three P2V aircraft on D minus 1 day, and to make a parallel search with two P2V aircraft out to 600 NM (and 240 NM wide) centered on the forecast direction of significant fall-out. The capability was also maintained and used on some shots, to search on Day Day in advance of the cloud. A further modification was made for the one shot at ENIWETOK to avoid excessive drain on aircraft availability due to numerous shot cancellations. An Area EVELYN was defined as a sector centered on the ENIWETOK Lagoon, 270° clockwise through north to 90°, radius 300 NM, plus a rectangular strip 60 NM wide and 600 NM long immediately adjacent to the south. Since the normal air particle trajectories generally moved toward the east as indicated in 4.d(1) above, the search of this smaller area, which could be accomplished faster (and therefore at a later starting time before H-hour) and with less aircraft, took advantage of the relatively clear easternmost portion of the 450 NM Danger Area without the necessity for

detailed searching. As before, the capability for searching in advance of the cloud on D-day was maintained.

(d) WB-29 aircraft on routine weather reconnaissance missions were instructed to report all sightings of surface shipping encountered. All such sightings (visual and radar) were relayed to the radar center in the TG 7.3 fleet.

(e) P2V aircraft and destroyer security sweeps were planned and utilized for the ENIWETOK-BIKINI Danger Area (i.e., the Danger Area originally established prior to CASTLE for security purposes). Information available from this source was channeled to the radar center of the TG 7.3 fleet.

(f) Information from all the above sources was relayed to the task force headquarters for evaluation and consideration at the Weather/Radsafe Command Briefings. Consolidation of all known shipping in the area was maintained by the TG 7.3 headquarters and summaries passed to the Radsafe OFFICE of the task force headquarters prior to command briefings. P2V sightings were passed to the task force headquarters and TG 7.3 direct from the search aircraft. Information on diversions of other shipping in the area was relayed to the task force headquarters by CINCPACFLT (through COMHAWSEAFRC and COMNAVFORMARIANAS as appropriate). A master plot of all shipping reported was presented by the Radsafe Officer at command briefings for consideration along with the many other factors involved in a shot decision. Except for the one incident (a Japanese fishing vessel) on BRAVO, all shots were detonated without significant effects on any shipping in the general area of the tests. The case of the Japanese fishing vessel on BRAVO is covered in detail in Inclosure 3 of Tabs H and K. Its presence was undetected primarily due to

the search aircraft running into contaminated air when approximately within radar range of the reported position of the vessel.

(4) Evacuation of native populations: The plans for evacuation of native populations were sound and well-executed, and should be used as a model for future operations. Certain aspects of the execution of the plan (Tab H) did, however, highlight some features which could help future operations. These are as follows:

(a) In the interest of safety and planning, detailed maps and operational data should be compiled on all northern Marshall Islands Atolls and placed in the hands of ship captains likely to be called upon to execute an evacuation. The element of uncertainty and risk experienced by the ships involved in the CASTLE native evacuations could have been avoided.

(b) Native populations could be prepared in advance of a test series in much the same way publicity is given to the test in the U. S. This would not only alert them to the fact that unusual phenomena would be manifested at various times, but would also provide an opportunity to assure them of the measures taken to provide for their safety.

(c) The success of an evacuation once it becomes necessary depends upon a rapid pick-up of the population; the task is made considerably easier if the natives are centrally located. Since the most prominent manifestations of a test are the light and sound emitted during the explosions, it would appear that native populations could be briefed to return to home islands upon perceiving these effects. Should an evacuation again become necessary, this factor alone could save considerable time. Such a condition existed for the Rongelap evacuation with the exception that the natives temporarily on AILINGINAE remained at that location. However, at each atoll

the natives gathered together to discuss the strange phenomena; the time required for the evacuation was consequently short.

(5) Cloud tracking: The term "Cloud Tracking", as used in the CASTLE Radsafe Plan, is probably more likely than not, a misnomer. The operations could be more precisely considered as "Aerial Surveys", being surveys of sensitive areas to detect the development of potentially hazardous conditions. Early in the planning stage of CASTLE it was realized that a strictly cloud tracking operation at the Pacific Proving Ground would be uneconomical if not practically impossible. Considering the availability of aircraft to engage in such work, and the nature of the answers which were vital from a safety standpoint, it was apparent that certain areas in the vicinity of the testing grounds were sensitive, whereas others were either not critical, or of interest only academically. It was also apparent that a cloud tracking effort of the type normally mounted for shots at the Nevada Proving Ground had little chance of success due to the extreme differential in cloud heights for the two proving grounds. Also, due to the fact that normally there are at least two major angular wind shear levels at the Pacific Proving Ground, a considerable number of aircraft would be required to follow each of the thre or more cloud segments formed, whereas the normal situation in Nevada is one low major shear level and therefor only the one major upper cloud segment to follow. To be perfectly precise, considerable angular shear is present in most Nevada clouds; however, relatively speaking, the sector of cloud travel in Nevada is very narrow compared to the wide sector of travel caused by complete reversals of wind directions in the Pacific. The normal conditions at the PPG latitude is east-northeast trade wind flow up to ten to twenty thousand feet, easterly flow above the tropopause (i.e., above approximately fifty-five thousand feet) and variable winds between. Since favorable shot

conditions require southerly components in the winds between the top of the trades and the bottom of the high easterlies, the shear angle at these two major shear levels varies from about 45° to 180°. In an effort to reconcile critical requirements with available equipment to do the work, a plan was devised as indicated in Tab E. This plan was followed on each shot with some modifications as indicated below:

(a) In an effort to improve the capability of assessing the effect of the depth of the trade winds on the amount and horizontal spread of contamination from this portion of the cloud stem, and to improve the capability of early fall-out warning for the ENIWETOK Atoll inhabitants during shots at BIKINI, an additional aircraft was utilized in the racetrack holding patter down-wind (tradewind-wise) from ground zero. This aircraft was flown approximately mid-way between the ground and the racetrack aircraft at 10,000 feet. The exact altitude was left to the discretion of the aircraft pilot in order to clear all natural clouds. The results of this effort indicate that for high yield barge shots at BIKINI, trade winds up to 20,000 feet have little effect on ENIWETOK, 180 NM distant. Information to this effect was normally available by about H plus 3 to H plus 5 hours for each shot.

(b) On some shots the racetract aircraft were also used to obtain aerial readings between the task force fleet and BIKINI Atoll and to survey damage and intensities on the BIKINI airstrip.

(c) The low-level racetrack aircraft was instructed to remair in its holding pattern until released by the Radsafe Officer. Normally, however, this aircraft was given another mission as dictated by the circumstances of the particular shot. The additional mission, as a rule, was to search a sector covering the northern Marshalls and to make low level passes

over inhabited atolls in the sector. Since this mission took place at about H plus 6 hours to H plus 12 hours, the readings taken during the low level passes (at approximately 200 feet), when extrapolated roughly to the ground, were sufficiently accurate to justify early assumptions relative to the presence or absence of hazardous contamination at those atolls. For shots subsequent to BRAVO the readings obtained indicated negative or insignificant contamination for all such low level passes. Consequently, no further action was taken for these atolls on shot day except to schedule a detailed precision aerial survey for D plus 1 day (NYKOPO KWAJALEIN Flight ABLE, Tab C, Incl 6). (No NYKOPO flights were made on shot day in order that sufficient time could elapse for fall-out to occur in advance of the flight and in order that the highly sensitive instruments used would not be rendered impotent due to high aircraft background arising from flight through contaminated air.) Use of the WB-29 for low level passes over the northern Marshalls was not made on BRAVO. For this shot the effort as planned and executed used a manned ground monitor station at the weather station on RONGERIK for early alert, and NYKOPO Flight ABLE on BRAVO plus one day. Unfortunately, the intensities experienced on RONGERIK exceeded the limit of the instrument supplied to the weather detachment (100 mr/hr maximum). The detachment's report of "instrument off-scale" was not viewed with alarm due to the fact that the task force fleet, much closer to ground zero, was experiencing intensities of 200 to 300 mr/hr at about the same time, plus the fact that cloud tracking operations in the RONGERIK area did not indicate intensities considered excessive in comparison. However, on the basis of the information known at the time, a monitor was dispatched by amphibious aircraft early the following morning and the NYKOPO Flight ABLE aircraft was directed to make an in-flight report upon reaching TAONGI. These actions resulted in positive information on the fall-out situa-

tion by about noon on BRAVO plus one day. Use of the WB-29 as a low level aerial monitor on the afternoon of shot days, as described above, was one of the post-BRAVO changes in the Radsafe Plan to improve the early fall-out warning capability of the task force. Among other measures, also taken, was the installation of a direct CW link between the WB-29 aircraft and the Radsafe OFFICE in order that more positive and rapid radsafe control of the aircraft flight could be assured.

(d) Although the capability of WB-29 coverage was maintained for the period of H to H plus 48 hours, only the first 24-hour period was used on all shots. This was due to the fact that intensities encountered as late as H plus 24 hours were in no instances significant and to the fact that the crews on normal weather reconnaissance flights (usually two separate flights) on D plus 1 day were instructed to make half-hourly radiation reports. As a consequence, cloud tracking coverage was maintained normally by two WB-29's flying from H plus 2 hours to about H plus 14 hours (i.e., the special low level racetrack and sector search, (Flight #1 of Tab E), one WB-29 flying from H plus 12 to H plus 24 hours (Flight #2 of Tab E), two WB-29's flying regular weather reconnaissance flights and reporting radiation encountered on D plus 1 day, and NYKOPO Flight ABLE flown on D plus 1 day.

(e) The original plan for radiation reporting provided for the cloud trackers to give readings in block values (i.e., 0-10 mr/hr, 10-50 mr/hr, 50-100 mr/hr, etc.). This was revised by a change in the reporting procedure to report the exact reading in mr/hr within the reporting block value given. Another change was made to indicate the type instrument used to make the reading. A further change provided for readings to be reported as gross values with no attempt made by the aircraft crew to subtract aircraft

background. This was considered necessary in the interest of safety in that the Radsafe Office could better evaluate the total dose rate to which the aircraft crews were subjected. In order to obtain true (i.e., net) readings, it was a simple matter for the Radsafe OFFICE to analyze a group of successive reported readings and determine this information by observation of rate of decay or increase. However, in the interest of flexibility in the reporting procedure, a further provision was made for the aircraft crew to indicate, as necessary, the value they considered aircraft background.

(f) Since the original plan for cloud tracking considered the early warning value of the ground monitor stations of the New York Operations Office, AEC (NYKOPO), the "off-scale" situation on RONGERIK for the BRAVO shot dictated the placement of higher range radiac instruments at critical locations. As a consequence, roentgen-range instruments were placed at all the outlying task force weather detachments (MAJURO, KUSAIE, PONAPE and the temporary water-based facility at RONGERIK) to augment the 100 mr/hr NYKOPO instruments. In addition, the WAKE Island station, operated by the Weather Bureau for NYKOPO, was provided with a roentgen-range instrument and requested to make special reports to the task force if and when intensities passed through 10, 50, 100 and 500 mr/hr. Also, the P2V squadron of TG 7.3 based on KWAJALEIN was directed to perform post-shot radsafe surveillance for that atoll and report readings directly to the task force headquarters. It was emphasized on CASTLE that ground monitor stations are a vital part of any successful cloud tracking plan, primarily because of the fact that aircraft surveys can only indicate the intensities seen by a radiac instrument in the air at some particular altitude. Although certain extensions and analysis of the totality of such aerial survey data can roughly indicate whether or not

the aircraft reading was taken before, during or after major fall-out, it remains for the fixed ground monitor station to bring about the necessary precision for firm long-range decisions. The primary and unique value of aerial surveys lies in the fact that large areas can be covered rapidly with, at least, order-of-magnitude precision. If such aerial operations are properl timed with forecast and observed winds, much of the uncertainty is eliminated; interpretation of the data obtained can provide extremely valuable and vital facts for timely and safe decisions pending the outcome of any necessary detailed and precise aerial or ground surveys. The BRAVO circumstances, however, emphasized that future operations in the Pacific should make maximum use of fully equipped ground monitor stations to augment cloud tracking, preferably manned stations with two-way radio facilities.

(g) Although the relative insignificance of CASTLE clouds more than 24 hours old resulted in cessation of major cloud tracking efforts at the end of the period of time, long-range intercepts of the cloud were requested from USAF - AFOAT-1 to augment and complete the record of any possible task force interest beyond 24 hours. These intercepts were usually made approximately D plus 2 or 3 days and indicated intensities considerably less than 1.0 mr/hr.

(h) In summary, the cloud tracking operations for CASTLE were highly successful considering the serious limitations on such efforts in the Pacific. The success of the operations was attributable to constant efforts to improve the techniques and aircraft utilization by analyzing the difficulties and circumstances of each shot as the test series progressed. This spirit of "profit by past experience" was the dominant aspect of the relationship between the weather reconnaissance crews and the task force

Radsafe OFFICE. The elimination of even the most minute flaws in the system, and recommendations for changes based on aerial tracking experience during the CASTLE shots, were the prime factors in the successful employment of long range aerial surveys on the test series.

(6) Support of Fall-out Program Conducted by the Health and Safety Laboratory, New York Operations Office, AEC (HASL NYKOPO): In an attempt to document the long range fall-out aspects of high yield shots at the PPG, the Health and Safety Laboratories (HASL) of the New York Operations Office, AEC (in coordination with the task force and CINCPACFLT) sponsored a program of ground, aerial and ship-board monitoring stations in the Pacific covering an area generally bounded by the equator to the south, Japan to the North, Hawaiian Islands to the east and the Philippine Islands to the west. Although this program was tied in with permanent HASL NYKOPO stations in the United States, the discussion here will be limited to the effort made in the Pacific. The detailed features of the network of stations is indicated in Inclosure 6 of Tab C.

(a) In addition to the major support items listed in Tab C, the task force headquarters made space and clerical assistance available in the Radsafe OFFICE for HASL supervisory personnel, provided communications facilities to the many outlying ground stations, provided transportation to all of the outlying task force weather stations, UJELANG and WAKE, and provided transportation assistance to such other sites outside task force control as was necessary. In addition, the Radsafe Unit of TG 7.1 made space and equipment available for storage and repair of HASL instruments.

(b) In turn, the HASL NYKOPO effort provided the task force with current data on the radsafe situation at the various ground stations and

the results of the aerial survey flights. Of primary value in this regard was the KWAJALEIN Flight ABLE which covered all the Marshall Islands Atolls north of KWAJALEIN. This flight was made as a matter of routine for the task force on the day following each shot. Since secondary fall-out (of no major significance to the task force) was forecast on some of the shots, Flight ABLE was frequently re-flown subsequent to D plus 1 day for the primary benefit of HASL documentation. KWAJALEIN Flights BAKER and CHARLIE (Marshall Islands Atolls southeast and southwest of KWAJALEIN) were not as a matter of course flown for task force interests except following BRAVO and during roll-up following the last shot of the CASTLE series. In general, the principal value to the task force of the NYKOPO flights during the operation lay in the use of the information collected to confirm forecast fall-out and cloud tracking results and to advise CINCPACFLT of the fall-out effects on inhabited Pacific areas.

(c) In addition to the flights indicated in Tab C, a special flight KING was set up following BRAVO to cover the Gilbert Islands on the assumption that some of the BRAVO contamination conceivably could have reached this area. Since the Gilberts are under British control, CINCPACFLT was requested to arrange clearance for the U. S. aircraft to overfly the islands. The flight was cleared with the British through the U. S. Naval Attache's office in London and flown on BRAVO plus 5 days; no significant intensities were encountered.

(d) Prior to the fourth CASTLE shot, the Division of Biology and Medicine, AEC, through HASL NYKOPO, initiated an effort to attempt documentation of the heavy down-wind fall-out by the use of styrofoam rafts. Preparations were completed in time for the project to be used on the YANKEE shot.

The rafts consisted of slabs of styrofoam approximately 5' x 5' x 4" fitted with small radio homing transmitters and balloon-elevated transmitting antennas. The rafts were dropped from transport aircraft starting several hours before shot time. The area covered was a 90° sector centered on ground zero. The orientation of the sector was determined on the basis of the latest forecast winds and forecast fall-out zone. Post-shot, two survey aircraft with large, highly sensitive scintillation-type counters were used to locate the rafts and measure the intensities of the contamination expected to be trapped in the porous styrofoam. Although location of the rafts proved to be the major operational problem (very few were found), the chief cause of failur of the project was due to the fact that intensities on the rafts were not appreciably different from the intensities read over the water near the rafts. Fortunately, however, failure of the raft program for the latter reason pointed the way toward a simpler and more practical method of measuring the downwind fall-out, namely, the use of low-level aircraft flights to execute a grid-pattern survey over the fall-out area taking readings of the intensity of the water itself. On the basis of the relatively sketchy results from YANKEE, the HASL group set up and executed a reasonably successful aerial water survey project for the last shot, NECTAR. (Note: CASTLE Project 2.5a, having lost the bulk of their open sea dan buoy fall-out collectors due to operational recovery problems and shot delays, also attacked the fall-out problem in a similar fashion. In general, the 2.5a plan on the last two CASTLE shots consisted of gathering water samples from various depths to determine radiation intensities and the various parameters affecting the mixing properties of the ocean and the taking of vertical radiation profiles by means of trollin a submerged radiac instrument.) The results of the HASL NYKOPO effort and the

Project 2.5a work will be presented in their final reports. However, the preliminary data from the work of these two agencies indicates that a combination of the two approaches to the problem will materially benefit previous incomplete documentation of PPG fall-out patterns and shows a great deal of promise for future operations. In fact, it appears that the problem of delineating the fall-out pattern for very high yield shots in the Pacific can be solved on future operations if major support is given to a project built around the findings of the two water survey methods outlined above.

(e) The HASL plan of operation provided for one man to be stationed at the task force command post as supervisor of the activities and one man (later two) to perform the necessary maintenance and setting up of instruments at the many ground stations. As the operation progressed it became apparent that the workload was somewhat more than could be accomplished by the team, especially in the matter of traveling around to the various sites to make repairs and adjustments to the instruments and in the matter of clerical assistance at the command post. The net result of the former was the necessity for setting up some special flights on an emergency basis, or the loss to the HASL project of data from a station if a visit proved impossible. The result of the latter was a constant drain on the clerical facilities of the task force. It appears that for the future, it would be less expensive and less disruptive of task force operations if more personnel were assigned to the project.

5. Protection of Task Force Personnel: The CASTLE plan of operation generally speaking was built on the premise that ENIWETOK Atoll was the primary base of operations and BIKINI was a forward shot area. As a consequence, the bulk of the personnel and equipment not directly concerned with a particular shot, plus the entire Army and Air Force Task Groups occupied

ENIWETOK for all BIKINI shots. At BIKINI the original plan to leave a firing party in the firing bunker on NAN was discontinued subsequent to BRAVO for safety reasons. No personnel were left on any other BIKINI site for any of the BIKINI shots. The problem of protection of task force personnel was solved as follows:

a. Personnel in the BIKINI area were completely evacuated (except for the firing party on BRAVO). Disposition of ships was made such that all personnel would be in the most favorable position with respect to the wind pattern and fall-out area and sufficiently distant so as to be safe from blast and thermal effects. Additionally, cloud tracking efforts were maintained to detect, in advance, areas of potential radioactive hazard up-wind of task force ships.

b. Since the evacuation of the primary camp at ENIWETOK Atoll as a result of fall-out from BIKINI shots would cause considerable expense, effor and subsequent delay in the operation, the wind patterns for the shots were carefully examined for possible adverse fall-out effects in the direction of ENIWETOK. In addition, as discussed in paragraph 4 under cloud tracking, a careful post-shot check was made of the air space between ENIWETOK and BIKINI in order, if required, to give advance warning of hazardous contamination likely to drift and fall-out on ENIWETOK. Lastly, a system of collection and reporting of Radsafe information from all populated areas of ENIWETOK Atoll was placed in effect from H-hour to at least H plus 24 hours, extended as required by special circumstances. It should be noted that primary reliance was placed upon the examination of forecast and observed wind patterns, plus the cloud tracking effort, inasmuch as these actions provided the maximum advance warning of potentially hazardous conditions up-wind of ENIWETOK.

e. For planning purposes it was assumed that some indication of the development of adverse conditions would be apparent from observed winds immediately post-shot and that cloud tracking should confirm the situation by about H plus 2 to H plus 5 hours. Assuming an average wind of 15 to 20 knots, the ENIWETOK garrison could be given a firm evacuation decision approximately four to seven hours prior to the arrival of contamination. Warnings, had they been necessary, could have been issued appreciably further in advance In addition to the above, an Eniwetok evacuation plan was placed in effect for BIKINI shots, with personnel on alert status until H plus 24 hours. The evacuation plan was designed on an austere basis to be accomplished relatively quickly with the minimum of personal equipment and aircraft and shipboard space. Levels of contamination requiring evacuation were not specifically set down inasmuch as each case would have to be considered on its own merits and demerits, and would depend upon the stage of completion of the operation, sites and yields of remaining events, and the average level of acquired personnel dosages. In general, the levels which could be tolerated without evacuation would be higher for shots late in the operation than they would be for the first shots. As a general rule, something on the order of two to three times the established MPE of 3.9r for the remaining period of the operation was considered acceptable without resorting to the complexity, expense and disruption of an evacuation.

6. Lagoon Contamination: A considerable amount of study was placed on the problem of contamination of the shot atoll lagoon and the attendent difficulties of surface operations as a result. The outcome of these studies is presented in Tab F. Briefly the studies indicated the following:

a. Both ENIWETOK and BIKINI Lagoons have "belt drive" current

systems, being wind driven on the surface and roughly against the wind from west to east on the bottom. The northern portion of the ENIWETOK Lagoon (as demonstrated on Operation IVY) appears to flush independently of the southern portion. At BIKINI, the entire lagoon as a unit is involved in the flushing mechanism, BIKINI Lagoon flushing at a relatively much slower rate than ENIWETOK.

b. Considering the shot schedule and the flushing mechanism of the two lagoons, the primary problem of ship operation in such waters was considered real only at BIKINI.

c. There existed a requirement that operations should be conducted in the lagoons without the inordinate delay between shots that would result from unrealistic contamination limits.

d. No health hazard was anticipated as a result of reasonable operations in the BIKINI Lagoon. The problem was anticipated to be primarily an operational nuisance.

e. The ships expected to be involved were the Weapons Ship, CVE, LSD, LST's, AN, ATF's and small craft.

f. The Navy Task Group was directed to initiate studies to determine methods of preventing concentration of activities in water evaporators, distribution lines and microorganic growths on the bottom of ships. In general, the problem of lagoon operation was as predicted except that the bulk of the transport was horizontal and downward. Very little, if any, up-welling of radioactive material occurred. On all shots except BRAVO, ships were able to re-enter the NAN anchorages by approximately H plus 6 to 10 hours. Following BRAVO, ships were kept clear of the lagoon until B plus 1 day. Following YANKEE (the last shot at BIKINI) re-entry was delayed (due to contamination at NAN Anchorage) until about H plus 10 hours. Upon

re-entry for YANKEE, personnel were re-grouped, following which, all ships put to sea (some to ENIWETOK, others scheduled for BIKINI roll-up, to remain overnight at sea due to water readings at the NAN Anchorage of approximately 20 mr/hr). Relative to the apparent lack of up-welling of radioactive material, some work was done early in the operation by Dr. J. Isaacs of Project 1.6 (Water Wave Studies) which disclosed a deep stratum of radioactive water which moved northwest toward GEORGE and HOW. This layer was quite concentrated just prior to KOON. Vertical sections were run at several stations using a dunked survey meter. The distribution was as expected with the astonishing addition of a stratum of clean water at about 110 feet overlying the radioactive water at 130 feet. Since no major storm was experienced during the operation, there remains for conjecture the effect of a violent disturbance of the lagoon. Whether or not this low-lying layer of radioactivity would be brought up and distributed more or less uniformly in depth by such a disturbance is not known.

7. Split Atoll Operations: The one single feature of the CASTLE Operation which made Radsafe somewhat difficult was the fact that coverage was required at both BIKINI and ENIWETOK Atolls. These two sites are separated by 180 miles; personnel transportation between the two sites was primarily by C-47 aircraft. As the operation progressed a point was reached at which a capability of firing a shot at each atoll was simultaneously maintained to take advantage of faverable winds occurring at one site and not the other. The principle adverse effect of this situation was the requirement to split the basic TG 7.1 Radsafe Unit personnel and equipment in order to be ready to operate regardless of which atoll became favorable for a shot. During the planning stage this unit was designed to move from one atoll to the other to

follow the shot schedule. Consequently, the total number of people in the unit was such that only a skeleton force was set aside for the opposite atoll. A further aggravating circumstance arose following the BRAVO event, namely, the requirement to roll-up the damaged and contaminated TARE camp and to maintain all activities ship-based. This required that the Radsafe Unit of TG 7.1 further split itself to cover each major ship housing personnel who normally worked ashore during daylight hours. Four major Radsafe Centers were required afloat at BIKINI alone. One of these was located at a hotel ship not originally designed to cope with mass control of personnel working in contaminated areas. The solution in this case was a barge (secured along-side) equipped with two squad tents for storage of equipment and office space, and decontamination showers drawing off the ship's water supply. Problems of dosimetry control became acute primarily due to the increased time required to collect film badges at a central laboratory, process the badges and return the results to the various ships prior to the next re-entry to shore installations. Personnel, equipment and instruments were spread thin in order to cover the essential shore work. The further requirement to operate simultaneously at both atolls was a particularly difficult matter. This problem was limited, however, to the TG 7.1 unit since the Radsafe units of the Army and Air Force Task Groups (TG 7.2 and TG 7.4) required no shift in their base of operations, and the Navy Task Group (TG 7.3) Radsafe unit was designed around relatively self-sufficient individual ship units.

PART THREE: FALL-OUT FORECASTING

1. Fall-out Forecasting Tools

a. Weather. Forecasts of radioactive fall-out depend primarily on forecasts of the wind field. Consequently, fall-out forecasts can be no better than the wind forecasts themselves. Much is yet to be learned about the tropical atmosphere. Great advances have been made in this field in the last two decades, but much is still unknown about the physical processes which affect and control the weather over the Marshall Islands area and consequently which change the wind patterns over this area. The winds aloft over this particular part of the tropics have always been considered very stable, with few variabilities - this fact is usually borne out by climatological statistics, but not by the day to day changes in the wind field, upon which winds aloft and fall-out forecasts must be made.

b. Winds Aloft Observations and Forecasts. The winds aloft forecasts themselves are only as good as the accuracy of the wind observations. Observational data of winds aloft are considered to be very accurate if made with GMD-1A equipment. All observations in the Marshalls were made with such equipment during Operation CASTLE with the exception of ship observations made by the USS CURTISS. Search radar installed aboard that ship was used for making the winds aloft observations; procedures with this equipment were considered of equal accuracy to the GMD-1A equipment. The observations and forecasts available during CASTLE were as follows:

(1) The weather observational network consisted of stations at ENIWETOK, BIKINI, RONGERIK, MAJURO, KUSAIE, PONAPE and KWAJALEIN, with data from MIDWAY, WAKE, MARCUS, GUAM, IWO JIMA and JOHNSTON being a most

valuable adjunct. Twice daily winds aloft runs were made routinely, with the runs being stepped up at selected stations prior to a shot period to as many as eight (8) runs per day. Runs to maximum obtainable heights were required; the averages were above 85,000 feet, with many runs reaching 120,000 feet.

(2) Planning forecasts as originally conceived were issued forty-eight and thirty-eight hours prior to each shot hour. The forecasts themselves consisted of winds for the shot site for each ten thousand foot level from the surface to ninety thousand feet. The winds were forecast to sixteen points of the compass and for an interval of speed to the nearest five knots.

(3) Following the selection of a specific shot time, detailed forecasts were issued at twenty-four, thirteen, eight and four hours prior to H hour. The details of these forecasts were far in excess of those in the planning forecasts; winds were forecast to the nearest ten degrees and to the knot, for two thousand feet increments from the surface to twenty thousand feet, for five thousand feet increments from twenty thousand to seventy thousand feet, and for eighty and ninety thousand feet.

(4) The above forecasts were obtained by the Radsafe personnel at specific periods prior to each shot. The forecasts, along with all available pertinent observations, were plotted as hodographs (wind vector diagrams) using a particle rate of fall of 5000 feet per hour to normalize the plot for further convenient computations.

e. Air Particle Trajectory Forecasts. In addition to the wind forecasts themselves, auxiliary air particle trajectory forecasts were

issued at H minus 24 and H minus 8 hours. These consisted of trajectories from the shot site for the period H to H plus 72 hours, and were for each ten thousand feet, from ten to sixty thousand feet. Revised trajectories for the same period were issued at H plus 6 and H plus 15 hours. Since the trajectories represented movement of air at specific constant altitudes, they were not directly useable for surface fall-out forecasting. Instead, the forecasts were used by Radsafe personnel primarily to assist in analysis of the long-range fall-out aspects and to alert other units of the Armed Forces relative to the probable locations and altitudes of areas of airborne radioactive particles. The trajectories were prepared by constructing prognostic charts for the period of time involved and using these charts to arrive at the trajectories. The number of prognostic charts varied with the simplicity of the systems, fewer being used with systems moving or developing slowly, and more for systems developing rapidly. The trajectories were derived mechanically by the superposition of one prognostic chart over another and making a smooth transition from the flow and speed field of one chart to the other.

d. Constant Altitude Balloon Flights. During the planning phase of CASTLE, it was proposed that a project be instituted whereby constant altitude balloons would be used to determine the feasibility of tracking radioactive debris at selected levels. This use of these balloons was predicated on the assumption that the movement of that part of the radioactive cloud debris remaining in the air at a particular level could be described by a balloon flown at the same level, the balloon and radioactive debris being simultaneously carried along. Since these balloons could be

tracked for periods of 48 hours or longer, and could be positioned each hour, a good system would be available for tracking the debris itself. Unfortunately, the balloon project was unsuccessful due to poor pre-launching checking procedure, an insufficient number of balloons to cover more than one or two flights per shot and improper type balloons for flight at the selected 40,000 foot altitude. This type project however, has potentialities, and should be reinstituted on a larger scale for future tests at the Pacific Proving Ground.

e. Results from previous operations. Due to the limited number of surface shots detonated prior to CASTLE, only a limited amount of data was available on the long range fall-out aspects of this type burst, and in particular, only the close-in phenomena were available for the one high yield type. As a consequence, the following general tools and assumptions were used in the planning for CASTLE fall-out forecasting:

(1) The IVY MIKE early crosswind and upwind iso-intensity lines were plotted as an over-lay on Bikini Atoll and assumed to represent (with allowances made for differences in yield and shot conditions) the close-in contamination that could be expected from a high yield land surface shot. This information was reasonably useful, however, as the operation progressed, a new technique to define close-in fall-out was developed. This method (Inclosure 3 of Tab D) developed by Dr. Thomas White, H-Div., LASL, appears promising, and is being further refined for future tests.

(2) Close-in intensities from barge shots in the lagoon (in approximately 100 to 150 feet of water) were assumed, due to the relatively small amount of solid material available, to be on the order of 1 to 10

percent as high as those resulting from a similar land surface shot.

(3) The long-range areas of fall-out were assumed to be reasonably represented by the method of vector summation of the winds (as used previously at the NPG and the PPG) augmented by an analysis of the forecast air particle trajectories. This assumption was modified following BRAVO by the development of a formal technique of fall-out pattern plotting taking into account the passage of the particles into different wind systems as the particles drifted away from Ground Zero (See para 4d (1) above and Incl 2 of Tab D).

(4) Since little was known quantitatively about the long-range variation in radiation intensities with distance and area, certain planning assumptions evolved from the numerous discussions during the planning stage of the operation and used as indicated below. Although the assumptions were general and conservative approximations, they were specific enough to be used as operational planning factors with a fair amount of confidence.

(a) CASTLE clouds more than twenty-four hours old were not assumed to be hazardous. Twenty-four hours travel of a CASTLE cloud was assumed to be approximately 500 nautical miles. These assumptions proved valid on the operation, except that there appeared to be relatively significant intensities in aerial regions beyond this time from the barge shots. Certainly, it could be assumed that the finely divided aerosol-type clouds from the barge shots would resist fall-out and therefore persist longer. It is difficult to assign a number to the period of time involved, although on the basis of cloud tracking operations for the barge shots, and considering the natural processes of decay and diffusion, it is not believed to be longer than thirty hours.

(b) Significant fall-out was expected to occur during the first twelve hours. Past experience in this matter seemed to favor a six-hour period for significant fall; however, since the off-site fall-out aspects of IVY MIKE were not known, the value of twelve hours was assumed for a margin of safety. BRAVO and ROMEO experience revised this assumption. It became apparent that something on the order of at least eighteen and possibly twenty-four hours would be more realistic, especially for surface land bursts. As a consequence, the new technique was developed (Incl 2 of Tab D) to approximate the significant fall-out area (significant fall-out area was defined as that area inside the 10r infinity iso-dose line) for the first twenty-four hour period. No basic change was made in the fall-out forecasting techniques as planned and used prior to BRAVO (Incl 1 of Tab D), rather the new method was used and presented at briefings to augment and modify results from the original methods.

(5) The method of plotting infinity dose envelopes by elliptical approximations (as proposed by ARDC Report "Radioactive Fall-out from Atomic Bombs", dated November 1953) was planned and used on the CASTLE series. This method is an empirical solution to the fall-out pattern based on the great amount of data from low yield shots at the NPG. Due to the great differences in yield and cloud heights for NPG and PPG shots, a strict application of the system on CASTLE was accompanied by an extremely low confidence factor, particularly for the first shot. There were no real assurances that the system described the high yield fall-out mechanism at all. For example, the trapping characteristics of the tropopause could only be conjectured, and if it was assumed to disregard the tropopause

as a barrier, there were no reliable indications of the height of super-tropopause cloud to consider as significant. Further, even if the above factors had been known, the fact that the only available long-range information on land surface bursts was limited to one low yield shot, left much to be desired in assigning reasonable numbers to isodose lines derived from the system. Consequently, as a general statement, it should be noted that, although this system of fall-out forecasting was used on BRAVO to augment other data, it was presented and limited to discussions of the relative merits of the assumptions and scaling upon which it was based. There was no real basis for assuming it was valid and as a consequence confidence could not be pushed to the point of over-riding the many other factors involved in the shot decision. As the operation progressed, and the observed fall-out effects provided some measure of answers to the many questions involved, the system was relied upon to a much greater extent. The major modification in the use of the method was to assign limiting altitudes of the cloud to use in applying the method. In general, the post-shot evidence of the finely divided aerosol-type cloud from the barge shots indicated a probable significant cut-off height at the base of the high easterlies (i.e. approximately tropopause height, or about 60,000 feet). It appeared that the tropopause trapping action probably has a significant effect on very small particles. On the other hand, it appeared from BRAVO that cloud heights for land surface bursts should be considered up to at least 60,000 feet and possibly to 80,000 feet. The fact that the BRAVO fireball itself went up to the tropopause may account for the difference. Many particles could possibly have been formed at altitude as well as

carried to these heights, and a large number of the total particles could have been large enough to over-ride any tropopause trapping action that may exist. In any event, use of this method more nearly describes the BRAVO results if altitudes up to 80,000 feet are considered.

(6) CROSSROADS BAKER was used to obtain an appreciation of the lagoon contamination which could be expected. This information together with other studies (Tab F) gave rise to the assumption that the phenomena would be more an operational nuisance than a hazard. It was assumed that ship operation could begin in the lagoon (except within a few miles of Ground Zero) by D plus 1 day, or at least by D plus 2 days. These proved to be valid assumptions. Work began by at least D plus 1 day on all shots, and, except for BRAVO, re-entry to the NAN anchorages was not prohibitive on the shot day itself. No appreciable radiation was encountered at the anchorages, except following YANKEE, when water intensities one foot from the surface were about 20 mr/hr at the NAN anchorage at H plus 10 hours. Nevertheless, the major ships were brought back in following this shot for re-grouping of personnel, following which all ships departed the lagoon, some to ENIWETOK, the others to remain at sea over-night. In general, it appears that the lagoon contamination encountered was that due primarily to fall-out and very little (except along western reefs) due to circulation. Principally, there appeared to be little or no up-welling of contamination by circulation, and consequently no appreciable spread of contamination by cyclic re-circulation of the lagoon. (See Tab J for further description of ship operation in the presence of significantly contamined water.)

(7) Particle size. As stated before, the hodographs (wind vector diagrams) were drawn normalized to 5,000 feet per hour rate of fall, i.e. one hour wind vectors were drawn for each 5,000 feet increment of altitude, and vectors for increments of less than, or more than 5,000 feet, were drawn with a length proportional to the ratio of the increment height to 5,000 feet. This amounted to considering the fall of particles of approximately 100 microns in diameter. Using the normalized hodograph, direct time and distance measurements could then be made in terms of 100 micron particles, and consideration made for any smaller sized particles by taking the distances doubled, tripled, etc. Prior to BRAVO it was assumed that particle sizes down to 70 microns should be considered; this amounted to doubling the distances taken directly from the normalized hodograph. After BRAVO, particle sizes down to 50 microns were considered to be significant and appropriate adjustments were made in the fall-out pattern.

(8) Diffusion. Prior to CASTLE the accepted factor applied to the construction of fall-out RADEXES to account for widening of the contaminated area with distance was the addition of a ten degree sector on each side of the RADEX area. For CASTLE, this factor was arbitrarily assumed to be fifteen degrees. Since so little was known about the fall-out mechanism of high yield events, and because of errors existing in other parameters of the fall-out forecast, it was assumed that some additional factor of safety was necessary, even though the value of the factor could not be precisely determined.

(9) Source size. IVY MIKE indicated that the current methods of predicting fall-out on the assumption of a point source (or at best, a very small source) were not acceptable for high yields. Consequently, CASTLE forecasting was originally made on the assumption of a circular source approximately 15 miles in radius (i.e. the approximate radius of fall-out crosswind and upwind from MIKE). BRAVO results indicated this to be somewhat small, and probably more like an ellipse with a semi-minor axis of about 25 miles. For the barge shots, the 15-mile circular radius (actually more elliptical than circular) appeared to be adequate. The net effect of the above was to consider the surface RADEX constructed on a point source type analysis as a generating element. Shifting the point source RADEX around a source area selected in accordance with yield and type of burst generated the complete area which should be considered in the surface RADEX. A similar adjustment was made to the Air RADEX forecasts with excellent results in defining the areas of contamination which resulted.

f. Construction of RADEXES and Fall-out Plots. Generally speaking, the RADEX area (RADiological EXclusion area) was considered to be a limited fall-out area for the first six hours post-shot in the vicinity of the test site and for the primary use of test personnel and equipment. Area fall-out plots were considered to be the entire area of significant fall-out, to include infinity isodose lines of at least 50 roentgens, and in some cases down to 10 roentgens. The RADEX was used as an operational device to define dangerous areas and to deny entry of task force units into certain areas except under specific authorization. As a consequence, it was given wide dissemination throughout the task force for the information

and compliance of all. The Fall-out Plot, on the other hand, being more general in application, was considered, with the RADEX, at Command Briefings for the over-all long range fall-out impact on populated atolls in the vicinity of the shot atoll. A detailed discussion of the methods of construction of hodographs, RADEXES and Fall-out Plots is given in Tab D. The discussion below is limited to certain generalities and specifics which apply to the Marshall Islands area generally, and to the CASTLE Operation specifically.

(1) Hodograph Examples. As a general rule, the winds in the Marshall Islands area are east northeasterly to easterly in the lower, or trade-wind, levels (up to about 20,000 feet), and easterly in the high levels (above tropopause height, i.e. at, and above, about 60,000 feet). The levels between are not only variable, but involve the most significant portion of the cloud from a fall-out viewpoint. Consequently, a discussion of favorable and unfavorable hodographs is primarily concerned with the mid-levels between 20,000 and 60,000 feet. (See Tab I.) Since the CASTLE Operation involved two shot atolls, the discussion which follows must consider the effect of a shot on one atoll on the populated areas of the other. The primary land masses involved in determining the relative favorability of the patterns are the two shot atolls, UJELANG to the southwest of ENIWETOK and the Marshall Islands in the southeast quadrant, particularly those to the east of BIKINI. (See Map: Native Populations in the Forward Area, Tab G). Generally speaking, wind conditions acceptable at BIKINI, are acceptable at ENIWETOK. The converse is not always true. An additional consideration is the fact that the two atolls will not always

have similar, or even acceptable, wind patterns simultaneously. Further, the relative favorability of any specific wind pattern depended somewhat upon the factors other than wind alone, such as yield, similarity of shot site conditions with the two general types discussed (i.e. land surface and lagoon surface barge types), stage of completion of the test series, previous efforts to evacuate both native and test personnel and variations in the height of the tradewinds (i.e. tradewinds appreciably in excess of 20,000 feet place ENIWETOK in an unfavorable position for BIKINI land surface shots certainly, and progressively so for barge shots).

(a) BIKINI hodographs: Patterns with mid-level winds from the sector southeast clockwise through southwest were considered favorable for all types of shots, with an extension of the sector to east southeast and west southwest for barge shots. The more southerly the components in these levels, the more favorable the pattern became, with the exception that mid-level winds moving strongly toward WAKE Island were considered to be less favorable for a land surface shot, but reasonably favorable for a barge shot. The limitations on the sector to the east and west were entirely due to the native atolls to the east and ENIWETOK to the west.

(b) ENIWETOK hodograph: For ENIWETOK, the acceptable mid-level wind directions were more flexible in two major respects. First, the limits on cloud travel to the east could be "stretched" somewhat to allow west southwest mid-level winds for all types of shots. This was due to the fact that the fall-out impact on BIKINI was not critical due to flexibility in plans for moving any test personnel from that area, and due

to the fact that a shot on ENIWETOK Atoll added another 180 miles cloud travel time between Ground Zero and the native atolls east of BIKINI. Second, the western limits of the favorable fall-out sector could be extended to the point of accepting winds from at least east northeast, and with reservations, from northeast. This was due to the absence of any land masses to the immediate west of ENIWETOK except UJELANG approximately 120 nautical miles southwest. The primary additional advantage of ENIWETOK therefore was favorability for "deep trades", i.e. easterlies throughout most levels, including the mid-levels, a situation not at all uncommon during the operation.

(c) Other considerations: The net result of the above was the relatively firm requirement for the mid-level winds to have directional components such that resultant winds to the levels involved could lay within the acceptable fall-out sectors, i.e. within the sectors west northwest clockwise to east northeast for BIKINI shots and from about southwest clockwise to east northeast for ENIWETOK shots. Although it would appear that the ideal shot atoll would be ENIWETOK, having a much wider acceptable fall-out sector, certain other factors entered into the decision, which, in fact, made this atoll less favorable. The primary factor was a consideration of yield. On the basis of MIKE results, it was considered hazardous to accept the relatively high probability of fallout, as well as blast effects, on the highly developed and populated camp sites at ENIWETOK. Although evacuation would have resolved the fall-out problem, the problem of attempting aerial operations from a base likely to require evacuation for both fall-out and blast, was just one of the major problems raised.

Further, although wind patterns could develop in which mid-level resultant winds lay in the acceptable sector, the vector summation of these winds must have sufficient southerly component to carry the bulk of the mid-level debris far enough north of Ground Zero so that the crosswind and upwind spread of contamination over the atoll does not overlap the camp sites. A not uncommon condition appeared at ENIWETOK several times during the operation in which the mid-levels to about 40,000 feet had southerly wind with westerlies above, such that the vector summation of all the levels placed the bulk of contamination within fifty miles to the north of Ground Zero. The proximity of the camp sites to the fall-out from such patterns, plus the added uncertainty of its stability (i.e. the uncertainty of the southerlies holding favorable) was the prime factor in not accepting such a pattern for ENIWETOK. This problem was relatively insignificant for Bikini Atoll shots, atoll contamination not being a problem due to completely ship-based operations at that atoll. The only "real estate" risk taken on BIKINI shots was that on the airstrip and on stations to be re-activated for another shot. Fortunately, the former risk turned out insignificant; the latter risk was overcome through efficient control of re-entry recovery and work parties. As a general statement, it would appear that the weight given to yield as a factor in the decision and choice of a shot atoll, should be revised. It would now appear that barge shots with yields and winds on the order of ROMEO, UNION or YANKEE could be detonated in the vicinity of MIKE crater at ENIWETOK without undue risk from fall-out. It would appear reasonable however, to maintain an evacuation capability in the event such became necessary.

(2) RADEXES:

(a) Surface RADEX: The forecast surface RADEX was obtained from the basic forecast hodograph. In detail, it was determined by the limiting bearings on the pattern of resultant winds drawn from Ground Zero to all significant levels. To these limiting bearings, an additional fifteen degree sector was added to allow for diffusion, changes in the wind pattern from that forecast and to allow for deviation from a point source origin of fall-out. Usually the RADEX consisted of two sector areas, one defining the low-level tradewind portion of the cloud, and the other, the mid-levels. For all surface RADEXES, a radial distance for the sectors was taken as that average distance representing six hours of fall at 5,000 feet per hour. This amounted to considering the outer area limits on the surface contamination resulting from the fall of particles of all sizes during the six-hour period. The surface RADEX was issued for a valid time of H to H plust 6 hours, and was revised as necessary due to changes in the shot forecast winds.

(b) Air RADEX: The forecast Air RADEX was constructed in the conventional manner (See AWS Manual 105-33). In general, the method used on CASTLE considered two general regions, i.e. the volume of contaminated air from 10,000 feet and up and the volume from 40,000 feet and up. The first volume was defined for the primary use of all test and service aircraft operating in the shot area from H to H plus 6 hours, and was disseminated for the purpose of assisting those aircraft in avoiding contaminated regions. The second volume was defined for the primary use of all

cloud sampling aircraft operating during the same period, and was disseminated for the purpose of assisting these aircraft in finding the best sampling area. In general, the construction of the air RADEX consisted of selecting an altitude at the bottom of the volume under consideration, considering this altitude as a surface, and constructing a hodograph on this "quasi-surface" using appropriate winds above the surface. Contaminated areas were then defined by the use of diffusion factors applied time-wise to the resultant winds obtained, and modified to account for deviation from a point source origin of fall-out. The air RADEX was also issued for a valid period of H to H plus 6 hours, revised as necessary, and disseminated to all test personnel with particular attention to its availability and use by the Air Operations Center.

(c) New Techniques: A new technique to define the close-in fall-out was developed to explain the shot atoll phenomena, and was used particularly to evaluate the forecast effects of NECTAR on the ENIWETOK camp site. (See Incl 3 of Tab D). This method, in general, employs a mathematical approach to the initial close-in distribution of fall-out.

(3) Fall-out Plots:

(a) The primary fall-out plot technique planned and initially used on CASTLE involved a joint analysis of the surface RADEX and the 72-hour air particle trajectory forecast to define the area of the first twelve-hour period of fall-out, and to formulate some opinion as to the orientation and extent of the area involved subsequent to the first twelve hours. For BRAVO an attempt was made to employ the method of

elliptical approximations described in 1f (3) (b) below, however, its use was extremely limited due to the great uncertainty as to its application for high yield events. As the operation progressed, it became apparent that a more meticulous method was needed to clearly define the fall-out from the high yields. The elliptical approximation method and a linear extension of the surface RADEX were both limited by the fact that they are built upon the ground zero winds. A new and dynamic method was needed to take into account the changes in the wind systems as particles drifted farther and farther from ground zero. At the request of the task force Radsafe Officer, Dr. Gaelen Felt of LASL and TG 7.1, working directly with Major O. W. Stopinski, Meteorologist from the Task Force Weather Central, undertook the development of such a method. The end result (static and dynamic plots) is indicated in Inclosure 2 of Tab D as used on the last three shots of the CASTLE series. It should be noted that all methods except the dynamic plot (Inclosure 2, Tab D), were used on the last five shots, and all methods on the last three shots. This was done to evaluate each method in its relation to others and because no single method was sufficiently tried and proved to the complete satisfaction of all. In this respect the Radsafe portion of the Command Briefings became somewhat complicated, although viewed in retrospect, it appears that a better appreciation of all the factors involved in the fall-out mechanism arose from this examination of the various different approaches to the problem. For example, the limitations of some methods were highlighted by others, and the presentation of old techniques simultaneously with the new, served to emphasise the need for better answers and the

relative amount of effort which should be expended in the future to get such answers.

(b) The method of elliptical approximations of the infinity isodose lines as mentioned in 1e (5) above was used on all forecasts from about H minus 18 hours up through the final pre-shot forecast. In general, the method consisted of circumscribing ellipses over the hodograph between major shear levels. The minor axes of the ellipses were determined by the amount of angular shear in the interval, and the roentgen values of the elliptical isodose lines and the over-all envelopes were determined by scaling. The entire method is based on empirical data from the NPG, however its successful use on the low yield shots at that proving ground, gave rise to an increasing amount of confidence in the ability of the system to predict the fall-out area after some of the difference between high and low yield shots had been progressively resolved during CASTLE.

2. Limitations of RADEXES and Fall-out Plots:

a. In general, RADEXES and Fall-out Plots suffer from the same "disease", namely, their complete dependence on the forecasts of the wind field. It is this one factor alone which primarily precludes the attainment of high precision in fall-out forecasting. Much has been done on Operation CASTLE to define the significant cloud heights for fall-out from high yield shots and to put numbers on predicted isodose lines. There is now a better appreciation of the time involved for significant fall-out to occur. The effect of the conditions of the shot site are better understood. Further, a significant step has been taken to release

fall-out plots from complete dependence upon the static ground zero wind system. But the fact still remains that any system of fall-out forecasting has a maximum upper limit in efficiency defined by the precision of the wind field forecasting. The discussion herein is not intended to imply that CASTLE weather forecasting was poor. To the contrary, this service during CASTLE was much superior to previous work at the PPG.

b. Since any improvement in the meteorological field will ultimately reflect itself in improved conditions in fall-out forecasting, it seems imperative that weather and radsafe people continue to support and assist each other and to maintain the close mutual interest in future operations as existed on CASTLE. Recognizing the limiting difficulties which constantly hound the weather forecaster in the Pacific, it seems that the logical future steps for both weather and radsafe forecasters are clear, namely,

(1) Continued research and study of tropical meteorology.

(2) Continued development of new techniques and refinement of the current fall-out forecasting systems, particularly those developed on CASTLE.

(3) Continued studies of particle-size parameters and the affect of the tropopause in the fall-out mechanism.

(4) In recognition of the possibility for error in either the weather or fall-out forecast, the development of mutual weather/radsafe techniques to "follow through" H-hour with complete post-shot forecasts and observations in order to obtain the earliest possible warning of the development of post-shot adverse fall-out conditions.

c. Steps were taken both during and after the CASTLE Operation in line with the above. Many of the concepts of the role of weather and its effects on the operation were changed. For example, the increasing importance of the problem of deposition of radioactive debris in the test area led to the beginning of a complete re-evaluation of the techniques of forecasting areas of fall-out and greater consideration of the long-range effects of the wind flow. It was found advisable to have a duty forecaster work directly with radsafe personnel during periods just prior to the shot. It was necessary for this forecaster to be completely familiar with the current flow patterns at all levels, and the forecast changes through twenty-four hours after the valid time of the forecast in line with the procedure for constructing air particle trajectory forecasts. In order to take into account the effect of the wind, the forecaster was prepared to give wind forecasts for levels as high as ninety thousand feet for a period of twenty-four hours over an area of approximately 500 miles in radius. The problem reached such a magnitude during CASTLE that continuing extensive work is to be done at the Los Alamos Scientific Laboratories utilizing the services of a qualified forecaster experienced in PPG weather requirements and the talent and know-how of scientists presently on duty there. It is felt that this problem is one of the most important to be solved for future weapons test operations. Of equal importance is the further research into improvement of weather forecast techniques and procedures for the Marshall Islands area, currently being extensively investigated by Dr. C. E. Palmer of the Oahu Research Center at Wheeler AFB, Hawaii. All of the above represents attempts to improve the systems

of Weather/Radsafe forecasting. There remains the last suggestion above, namely, better use of existing techniques to "follow the shot through". In recognition of the fact that forecasts can fail, the system should provide a measure of advance warning in order that appropriate measures could be taken early to avoid the severe aspects of unexpected fall-out. On CASTLE the Weather Central maintained a continuous schedule of post-shot observations by its network of stations. These were studied by radsafe personnel in conjunction with revised air particle trajectories, cloud tracking efforts and reports from manned ground monitor stations. Continuing the complete pre-shot type weather/radsafe forecasting techniques from H hour through about H plus 24 hours could considerably improve the results of these efforts.

PART FOUR: RADSAFE ORGANIZATION (See Charts 1 & 2)

1. Task Force Headquarters RadSafe Organization: During the planning stage of CASTLE, staff work required to set up the necessary services and procedures to cope with the Radsafe problems was well within the capability of one officer and one clerk stenographer. However, once the shot phase of the operation started, the work-load became considerably greater.

a. In particular, the requirement existed for a Radsafe officer, completely conversant with the entire Radsafe plan of action, and with the developing Weather and Radsafe situation for the shot, to be on duty from about H minus 24 hours to approximately H plus 24 hours. It was during this period that the crucial Radsafe work had to be done. Prior to the shot, a succession of command briefings (at least 4) required a considerable amount of preparation of briefing displays for wind patterns, fall-out plots and transient shipping information. Along with the briefings, a string of advisories and directives were required to go out to various agencies both external and internal to the task force, some of which occasionally required revision in accordance with significant changes in the wind forecast. After the shot, the problem became one of reconnaissance to determine the close-in and long-range fall-out aspects. Answers had to be obtained relative to the safety of task force ships; the problem of aerial contamination drifting toward ENIWETOK and UJELANG Atolls required early evaluation; winds aloft observations had to be plotted and continually analysed together with both observed and forecast fall-out information; constant checks were required on the cloud sampling operation to assure the conduct of these operations in accordance with reasonable radsafe precautions; advisories again were required to inform internal and external agencies of critical developments;

cloud tracking operations had to be continuously and closely monitored and analysed relative to populated areas contiguous to the tests sites and necessary adjustments made according to the developing situation; information on lagoon and island contamination had to be analyzed and re-entry plans made accordingly. On a normal shot, the tempo of the Radsafe operations decreased considerably by about H plus 12 hours, however, the remaining activities (limited primarily to cloud tracking) required the continued presence of a qualified Radsafe officer until at least H plus 24 hours. The net result of the above was a shot-phase requirement for additional personnel to assist in the required functions. For this purpose the task force Radsafe staff agency was designated the Radsafe OFFICE during the shot period (as distinguished from the Radsafe CENTER, the primary operational and informational center of the Radsafe Unit of TG 7.1). Additional personnel were gathered together in the Radsafe OFFICE on a temporary duty basis for the shot period to perform portions of the various functions and to maintain a continuous 24-hour duty status. These personnel and their temporary assigned duties were as indicated in the functional chart of Tab G.

b. The Radsafe OFFICE for shot times was designed to be the primary task force shot-time agency for all radsafe matters requiring headquarters staff action and for all radsafe information having an impact on the various operational decisions which were expected to arise. Its sources and channels of information were as indicated in the Radsafe Check List, the functional chart and the communication facilities charts of Tab G. These facilities were, with minor exceptions, completely adequate for their purpose.

c. As stated above, one of the primary functions assigned to the Radsafe OFFICE was that of conducting the Radsafe portion of the Command

Briefings for shot decisions. This particular function alone accounted for a major portion of the Radsafe Officer's time. In general, the subject matter of the briefings covered not only the primary function of detailed forecasting of fall-out areas, but also covered many operational problems or plans upon which the radsafe situation had a greater or lesser impact depending upon the wind pattern. A detailed account of the factors considered during the radsafe portion of the command briefings is presented in Tab G. Briefly, these consisted of the presentation of the forecast and the observed hodographs relative to the development of the wind patterns during representative intervals prior to the briefings, the surface RADEX for H to H plus 6 hours, the forecast outlook for various critical atolls in, and contiguous to, the test area, and the outlooks for task force ships, transient ships, air routes and surface routes. The presentation also included information recommended for the task force commander's routine advisories to CINCPACFLT relative to the mutual Task Force and CINCPACFLT responsibilities for populated areas in the Pacific and protection of air and surface shipping. As a normal rule, a full briefing as outlined above was given at approximately H minus 18 hours and H minus 6 hours. Abbreviated versions, consisting primarily of the forecast and observed hodographs, were normally given at approximately H minus 36 hours, at H minus 12 hours and at approximately H minus 3 hours.

d. The secondary function of the Radsafe OFFICE, to maintain displays for briefing and record purposes, required an assembly of suitable charts of such a size to allow complete mobility. The mobility feature of the displays was a critical feature. On the command ship, for example, briefings were held at some distance from the space alloted to the Radsafe

OFFICE. The charts used for briefing purposes had to be of such size to allow them to be carried through the narrow ship passages and up ladders, and yet large enough for the entire command briefing group to read with ease. Due to the split-atoll operation, and the eventual establishment of the capability for firing at either atoll simultaneously, some of the Radsafe briefing and display charts, files and plotting equipment had to be amenable to quick packing and ease of transport. As a consequence, all charts were mounted on 30" by 40" heavy carboard and covered with acetate. Posting of information was done with china marking pencils. For rapidly changing data, permanent records were made on separate small forms during the progress of the shot. The remainder of the data was transferred to permanent record charts or forms at the completion of the shot. In general, the briefing and record displays used were as follows (a detailed description of each is given in Tab G):

(1) Briefing displays consisted of several polar charts for the display of all pertinent observed and forecast hodographs and the surface RADEX, a chart (prepared by the Weather Central) for the forecast air particle trajectories, charts for fall-out plots for each of the methods in use for the shot, a chart showing the danger and search areas together with pertinent contacts made by search aircraft, a chart showing the transient shipping in and near the Danger Area, and a chart indicating the locations and populations of atolls in the general area.

(2) Radsafe OFFICE record displays consisted of the above briefing charts plus the following: The Air RADEX, Cloud Tracking Operations chart, Shot-atoll radsafe situation plots, Off-site radsafe situation plots, and charts for the recording of radiation intensities on task force ships,

the status of reccoery and critical weather and sea information.

e. Additional responsibilities of the Radsafe OFFICE involved Liaison with representatives of the Health and Safety Laboratory, New York Operations Office, AEC (HASL NYKOPO), with the task force Biomedical Advisor and Staff Surgeon, with AFOAT-1 representatives, and with other special advisors to the task force commander.

(1) The first responsibility involved the furnishing of working space, clerical assistance and task force Radsafe data to the HASL NYKOPO group. In turn, the HASL NYKOPO group made available to the Radsafe OFFICE all data collected by aerial surveys, fixed stations and ship stations and maintained pertinent situation charts in the Radsafe OFFICE. In addition, the HASL group provided and maintained four newly developed HASL scintillation-type gamma rate meters for use in WB-29 cloud tracking operations.

(2) The second responsibility involved close coordination with the task force radiation medical adviser on such matters as health hazards on distant atolls, waiver of MPE, staff action on over-exposures, and health aspects of special cloud sampling missions. The policy of maintaining on the task force staff a medical officer specifically trained in the radiology field and with field experience on nuclear tests was most profitable in the proper handling of major radiation incidents. Further, it provided a qualified medical authority available during the test to preclude minor radiation incidents reaching absurd proportions or causing undue adverse reactions in commands or agencies external to the task force. The officer selected was assigned to the task force on a TDY basis since his presence on the staff was required full-time only during the actual shot period. It was agreed that, during the planning stages of the operation, interim services as

necessary, could be accomplished on a consultation and coordination basis.

(3) The third responsibility involved the furnishing of pertinent radsafe information to AFOAT-1 on initial cloud drift and ready access to facilities allowing early AFOAT-1 evaluation of cloud sampling results. Weather information was also made available to AFOAT-1 by the Weather Central, directly in some cases, and through the Radsafe OFFICE in other. The favorable physical location of the Radsafe OFFICE with respect to command post facilities and information sources, together with the Radsafe OFFICE/AFOAT-1 mutual interest in cloud sampling, drift and tracking was the primary basis for the eventual liaison working status accorded the AFOAT-1 representative at the task force command post.

(4) Other special advisors were integrated into the work of the Radsafe OFFICE as necessary by the circumstances of specific shots. In particular, one advisor for Radsafe matters was assigned specific functions for all shots as indicated on the functional chart in Tab G.

(5) As a result of the above arrangements, and considering the personnel manning problems indicated in paragraph 1a above, the HASL NYKOPO and AFOAT-1 representatives and the task force advisors were integrated into the Radsafe OFFICE as working members during shot times. Specifically, the HASL NYKOPO representative was assigned responsibility for current information and displays on matters of mutual interest. The AFOAT-1 representative was assigned the function of Radsafe Air Operations Officer with the particular function of supervising the task force cloud tracking plan. The Biomedical Advisor was assigned supervision of the off-site surface radsafe situation, particularly in regard to the health hazard aspects and was made responsible for staff action on waivers of MPE and over-exposures.

The Radsafe Advisor was assigned specific functions primarily to assist and advise the task force Radsafe Officer. All personnel integrated in this manner were considered under the direct control of the task force Radsafe Officer during critical shot times only. In general, the detailed Radsafe "Check List" items were assigned to the individual for whom the information was of primary interest. In some cases, assignment was made to the individual whose information from other sources had a direct impact on the action required. In the latter cases, it was the responsibility of action officers to effect the necessary coordination on outgoing and incoming information.

f. Project Book. In order to integrate the various personnel into the Radsafe OFFICE, a Project Book was issued to be used as the Radsafe OFFICE Handbook during shot times. This book contained detailed instructions, check lists, maps, example messages, reporting codes, communications facilities and voice calls, safety instructions and such other references as were considered necessary for frequent use during the shot. (Some of the major items contained in the Handbook are attached in Tab G.) The Handbook, coupled with the mutual interest and enthusiasm of all concerned, were the primary factors in quickly arriving at an efficient organisation of personnel gathered together briefly from several sources and working toward a common goal.

g. Special communications facilities. Two special radio circuits were brought into the Radsafe OFFICE for the sole use of Radsafe traffice. The first of these was VHF voice circuit with the TG 7.1 Radsafe CENTER for the interchange of information of mutual interest. The second, was a CW station used primarily to intercept WB-29 cloud tracking reports and to relay radsafe instructions direct to the WB-29's from the Radsafe OFFICE. These two circuits were vital to the successful accomplishment of the Radsafe Plan.

h. Tape Recorders. Considerable use was made of tape recorders to preserve the abundant verbal information available during the first few hours after shot time. Particular use was made to record conversations over the direct VHF channel with the TG 7.1 Radsafe CENTER. In general, the tape recorders served as a convenient method during the Radsafe OFFICE "rush hour period" to preserve information until such time as the significant portions could be extracted for the record.

2. Task Group Radsafe Organization: Since Radiological Safety, similar to other forms of safety, is a command responsibility, each task group was directed to set up its own self-sufficient Radsafe Unit. The delegation of the major detailed radsafe responsibilities of the task group units was contained in Annex N to CJTF SEVEN Operation Order 3-53 (TAB A).

a. In general, each task group unit was directed to be self-sufficient in terms of manpower, equipment, maintenance and training. Each unit was designed to cope with the routine radsafe matters and those problems unique to the particular service, agency or functions of the task groups. In addition, each task group unit was delegated special functions to perform for the primary benefit of the task force as a whole and for which the particular groups designated either had a direct interest or were particularily adapted to the accomplishment of the function. These were as follows:

(1) Task Group 7.1. The TG 7.1 Radsafe Unit was charged with the major functions concerning on-site recovery operations. Specifically, it was designed to perform the radsafe control of all working parties in contaminated areas regardless of the task group involved. The principal problem in this function was the control of personnel engaged in recovery operations, post-shot clean-up and making-ready for the next event. Other

special functions included the photodosimetry program for the entire task force, laboratory radiochemical analysis of water and other type samples, control of packaging of radioactive sources and samples, provision of the necessary personnel, plans and equipment to accomplish such special and unusual radsafe services as required during the operation, and the assumption of TG 7.5 radsafe responsibilities during the on-site phase of the operation.

(2) Task Group 7.2. The unit of this group provided monitors for security sweeps of both atolls and maintained a pool of trained monitors and decontamination operators as required for emergency back-up of TG 7.1. The idea of maintaining a pool of back-up monitors and decontamination operators arose from efforts to reduce the total number of personnel assigned to the Radsafe Unit of TG 7.1. It should be noted that manning with a large number of personnel whose only duty is Radsafe Monitor, is, to a great extent a waste of manpower. Personnel in this category have little productive work to perform except in connection with plans for recovery trips and the performance of monitor duties during the relatively short period of the recovery trips. Further, since the radsafe responsibilities of TG 7.2 were relatively light compared to the other groups, and since there was a definite need for TG 7.2 radsafe know-how during the interim garrison phase as well as during the relatively light operational phase, TG 7.2 was selected to train the "additional duty" monitors and decontamination operators required This solution assured coverage of TG 7.2 internal radsafe problems, and, at the same time, provided TG 7.1 with the necessary emergency back-up within the framework of a more streamlined and conservative-sized unit.

(3) Task Group 7.3. This group provided facilities afloat

for completely ship-based recovery operations together with the necessary helicopter services. It further provided for the basic radiological safety of embarked task force personnel during periods afloat. In addition, and inasmuch as TG 7.3 had a prime interest in the post-shot contamination status of the lagoon, the Radsafe unit of this group was directed to prepare plans for lagoon water sampling by helicopter and small craft. Samples collected in this manner were analyzed by the TG 7.1 radsafe laboratory and the results used by the task force headquarters initially for re-entry decisions, by TG 7.3 for continuing ship operation in the lagoon and by TG 7.1 in scheduling recovery and make-ready operations.

(4) Task Group 7.4. The unit of this group, with the assistance of interested scientific project personnel of TG 7.1, was charged with the radiological safety of the aircraft cloud sampling program. Over a period of operations both at the NPG and the PPG, procedures and equipment had been developed to cope with the unusual problems involved in cloud sampling. CASTLE, however, presented a more complex problem due to the large number of high yield events and due to a plan for early (H plus 1 to H plus 2 hour) low level (10,000 to 20,000 feet) special sampling by WB-29 aircraft. Further, since the Air RADEX was of primary interest to the Air Task Group, the responsibility for preparation of this RADEX was given to TG 7.4. Actually, the TG 7.4 technician involved worked physically with the Radsafe Office at the task force command post, and with the TG 7.4 Air Operations Center, in preparing the RADEX which was ultimately put out to all task groups as a task force directive. In addition to the above, TG 7.4 was charged with the necessary aircraft operations involved in the conduct of the task force cloud tracking plan.

(5) Task Group 7.5. This group was relieved of radsafe responsibilities during the shot phase of the operation. Since its general requirements for radsafe services were similar to those of TG 7.1, i.e., control of working parties in contaminated areas, its responsibilities for radiological safety were delegated to TG 7.1 during the shot phase. TG 7.5 was, however, charged with making plans and conducting on-the-job training with the TG 7.1 Radsafe Unit preparatory to assumption of radsafe responsibilities for the entire PPG (Except ENIWETOK Island) during the interim operation period following CASTLE.

b. Personnel. With the exception of TG 7.1, the bulk of the radsafe personnel for the entire task force were "additional duty" types with a few "primary duty" staff and supervisory people. For example, the Army Task Group trained "additional duty" personnel in each activity of the group, concentrating to some extent on the Military Police. The Navy Task Group placed radsafe under Damage Control in accordance with routine Navy organizational practices. The Air Task Group utilized flight crew members as monitors and maintenance personnel for aircraft decontamination since the major problems were encountered during flight and during post flight aircraft wash-down and maintenance. Since the AEC Task Group's problems were similar to those of the Scientific Task Group, the latter, as mentioned above, assumed overall shot phase responsibility, with the understanding that the former would assume the relatively light work load during the interim operational period using TG 7.1 equipment retained in the Forward Area and TG 7.5 personnel trained on-the-job. The one exception to the "additional duty" policy was in the case of the TG 7.1 unit. Since this unit was designated the major Radsafe Unit for on-site operations and given the responsibility for specific centralized and highly technical radsafe services, considerable manning problems had to be solved to assemble the necessary

"primary duty" technicians. However, even for this unit the "additional duty" philosophy was utilized for personnel economy. For example, each project had one or more working persons within the project specifically designated and trained by TG 7.1 to perform routine radsafe recovery monitoring for the project. In addition, TG 7.2 had been directed to train 50 "additional duty" radsafe monitors and 10 decontamination operators for emergency back-up of the TG 7.1 unit if such a requirement proved necessary. Consequently, the TG 7.1 Radsafe Unit was able to reduce its radsafe monitor section to approximately 10 people. This small number of highly trained monitors were used in particularily critical circumstances or in fields of unusually high radiation.

c. Equipment and Maintenance: Each of the military task groups was directed to procure radsafe equipment from sources of their own service. TG 7.1 was directed to procure standard military equipment from military stocks, and the remainder (non-standard items) by purchase. In accordance with previous agreements, the AEC had agreed to purchase all necessary items non-standard to the military services; standard military items were to be furnished as normal service support. In the matter of maintenance and repair, each task group was directed to provide its own facilities, with the exception that the major repair facility of TG 7.1 was made available to assist if necessary. TG 7.5 problems in this matter were solved under TG 7.1 plans.

d. Training: Individual and group training was conducted by the staff and supervisory personnel of each group, using task group schools and the various service schools as necessary and available. Also, each task group was assigned at least one Radiological Defense or Nuclear Engineer, together with appreciable numbers of other personnel with varying levels of

experience. In the case of the TG 7.3 ships, much of the training of the crews had been completed, on separate direction, prior to the ships' reporting to the Navy Task Group. In each task group, training emphasis was made in accordance with the major problems each task group expected to encounter.

e. Personnel Dosage Records. As indicated in Tab A, the responsibility for personnel dosage control, including the supply and processing of film badges, was placed under the Radsafe Unit of TG 7.1. The reasons for assigning this service to TG 7.1 were as follows:

(1) The primary users of the film badge would be the members of the scientific task group during recovery operations. Use of the film badge by other categories of personnel would be essentially limited to representative distribution among groups of personnel in order that a dosage could be assessed in the event of unexpected contamination of the groups.

(2) The film badge is not a standard item of military issue through-out the three Services.

(3) Although each task group has a command responsibility for its own radiation safety, the setting up of a photo-dosimetry supply and laboratory in each task group would not only be uneconomical from a workload viewpoint, but of far greater importance, would result in a confusing lack of uniformity among the task groups in the choice of the type of film badge for issue and in the processing procedures used. Considering the fact that the film badge types presently available for personnel dosimetry are normally susceptable to inaccuracy for a variety of reasons, the choice of one central supply supply and processing laboratory removes at least the two

variables of film badge type and processing procedure.

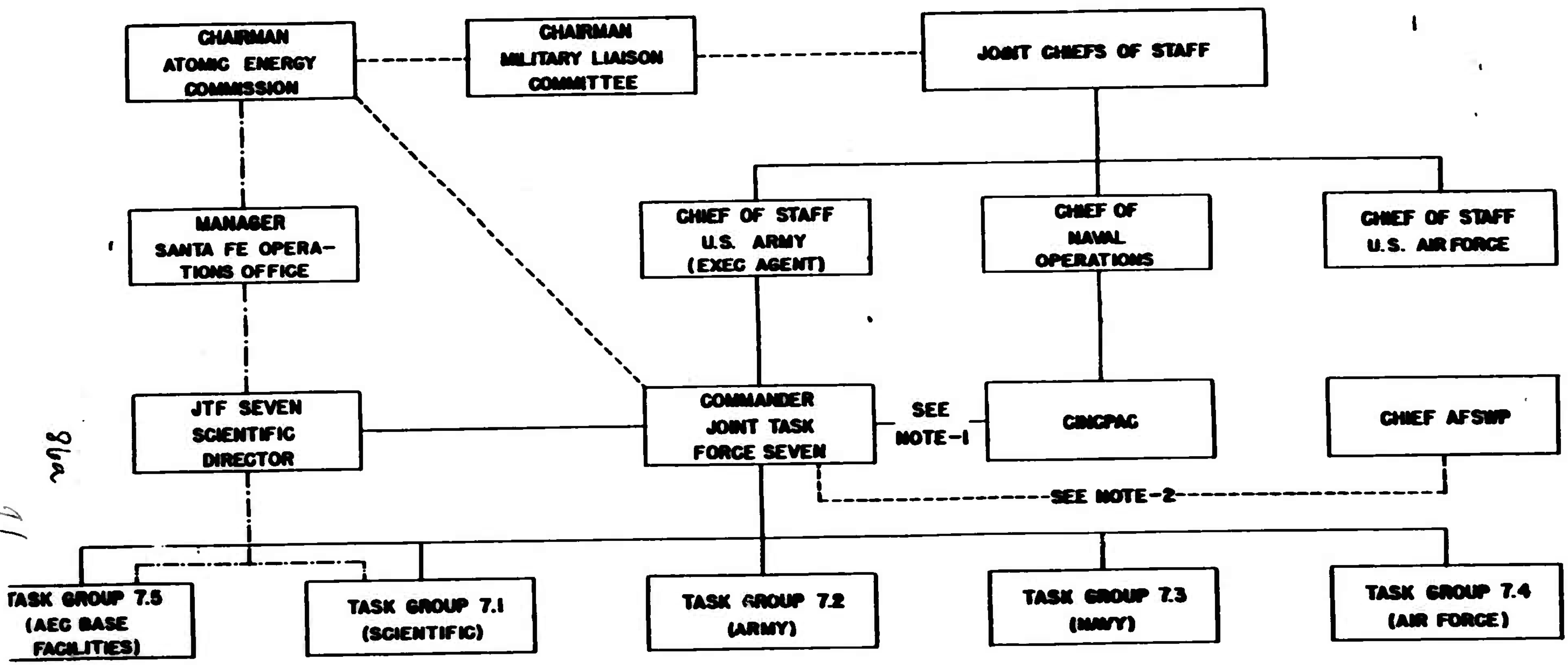
(4) Centralization of highly skilled technicians assures standardized and reliable radiation dosage measurements amenable to comparison on an over-all military and civilian basis.

(5) From the personnel manning standpoint, the centralization of highly technical Radsafe services results in the most economical assignment of the limited number of highly skilled technicians available. Since the major radsafe working unit was assigned to the scientific task group, the photodosimetry program was considered to be best placed in this unit.

2 Incls:
1. Organization Chart
2. Organization Chart

ORGANIZATION FOR OPERATION CASTLE

(ON-SITE PHASE)



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GEND:

—— OPERATIONAL CONTROL

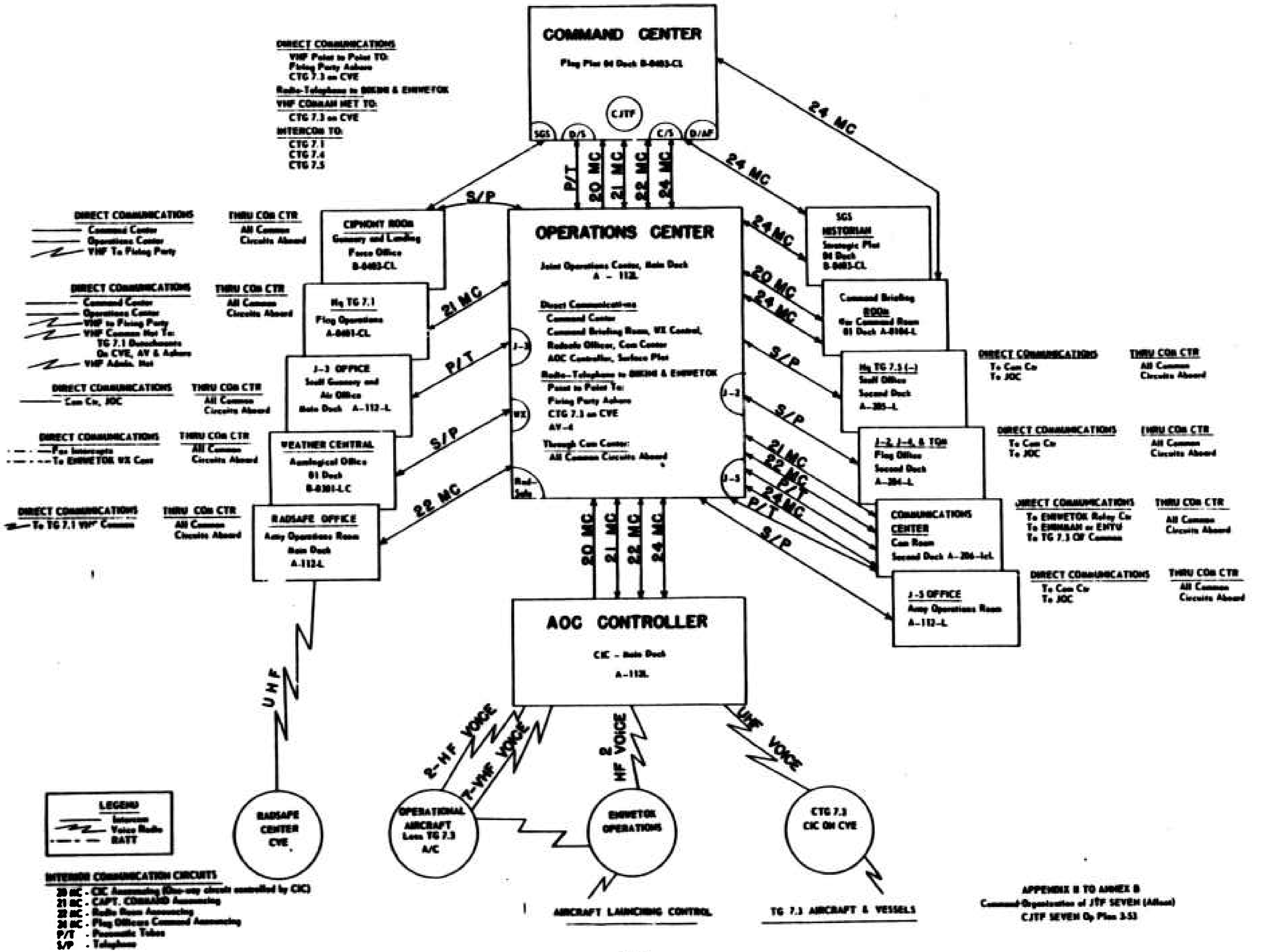
----- LIAISON

-·-·- AEC POLICY

NOTE 1: BY DECISION OF THE JCS ON 13 APRIL 1953, THE COMMANDER OF THE JOINT TASK FORCE WILL REPORT TO THE APPROPRIATE COMMANDER UNDER THE JCS (CINCPAC) FOR MOVEMENT CONTROL, LOGISTIC SUPPORT AND FOR THE PURPOSE OF GENERAL SECURITY WITH RESPECT TO THE TASK FORCE AND ENIWETOK ATOLL (LATER BROADENED TO INCLUDE BIKINI ATOLL). IN THE ABSENCE OF THE TASK FORCE COMMANDER FROM THE ENIWETOK AREA, THE SENIOR TASK FORCE OFFICER PRESENT WILL, AS ACTING, REPORT TO CINCPAC FOR THESE PURPOSES.

NOTE 2: BY DECISION OF THE JCS ON 23 APRIL 1953, THE CHIEF OF THE ARMED FORCES SPECIAL WEAPONS PROJECT (AFSWP) WILL EXERCISE, WITHIN ANY TASK FORCE ORGANIZATION, TECHNICAL DIRECTION OF THE WEAPONS EFFECTS TESTS OF PRIMARY CONCERN TO THE ARMED FORCES AT ATOMIC TESTS CONDUCTED OUTSIDE THE CONTINENTAL UNITED STATES. PRIOR TO THE ON-SITE PHASE OF AN OVERSEAS TEST OPERATION, THE TASK FORCE COMMANDER WILL CONSULT THE CHIEF OF AFSWP ON MODIFICATIONS OR DELETIONS TO THE DEPARTMENT OF DEFENSE WEAPONS EFFECTS TEST PROGRAMS.

COMMAND CHANNELS JTF SEVEN (AFLOAT)



APPENDIX II TO ANNEX B
Command Organization of JTF SEVEN (Afloat)
CJTF SEVEN Op Plan 3-53

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PART FIVE: CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

a. General:

(1) The significant fall-out area from large yield shots was a zone on the order of 100 miles wide and 300 miles long. Because of variations in the wind forecasts, diffusion of the atomic cloud along its path of fall-out and changes in direction of drift of the cloud as it moves outside the influence of ground zero winds, a much larger exclusion area had to be considered associated with the forecast fall-out zone.

(2) The employment of large numbers of search aircraft to sweep vast forecast fall-out areas was an expensive operation. Successive daily repetition of the sweeps was often necessary due to shot delays arising from unfavorable winds and the difficulty in making accurate long-range weather forecasts.

(3) Although the size of the area set up prior to the operation for diversion of transient shipping was adequate, it did not extend to all nationalities.

(4) The adoption, after the first shot, of a large Danger Area for the remaining period of the CASTLE Operation was the logical solution to the transient shipping problem for two major reasons:

(a) The Danger Area applied to all nationalities.

(b) Due to advance clearance of the entire Danger Area, aerial sweeps of the major portion of this area were basically in the category of checking compliance with the Danger Area notice rather than attempts to contact and effect time-consuming diversion of shipping. As a consequence, the sweeps were made later in the pre-shot preparations and with less chance of repeats arising from shot delays due to weather.

(5) The sources of information on transient shipping, coupled with the Danger Area modification discussed above, were adequate for protection of all surface shipping following the first shot.

(6) Advance plans for evacuation of the ENIWETOK camps and native atolls for fall-out were adequate.

(7) Ship operation in the shot atoll lagoon was not a serious contamination problem. Detailed sampling of the lagoon water at critical locations and countermeasures taken by ships' crews were adequate to cope with the operational nuisance encountered. Available evidence indicates that contamination in the lagoon waters concentrated on downwind reefs and in the lower levels of the lagoon. Since no violent storms were encountered on the operation, the effects of such disruptions in producing uniform mixing of the contamination are unknown.

(8) The relations and agreements developed for the mutual discharge of CINCPAC (CINCPACFLT)/JTF SEVEN responsibilities relative to the safety of Pacific populations were adequate. Minor exceptions are indicated below:

(a) Native populations were not briefed in advance on the general aspects of the operation, to include approximate starting date of the operation, gross phenomena which would be manifested, possibilities of hazardous conditions requiring evacuation and general native preparations to centralize and anticipate evacuation.

(b) Native atolls were not provided with manned monitor stations and film badges.

(9) The MARSHALL Islands in the southwest quadrant were originally considered to be in a favorable location with respect to fall-out.

However, the air particle trajectories for each shot indicate a similarity in that, regardless of the initial directions of the winds, the mid-level winds normally shifted to westerlies at varying distances from ground zero. The net consequence of this action was the eventual transport of the most significant layers of contamination to the east. Upon subsidence of the debris into the tradewind flow, contamination was brought back into the general area of the tests and the northern Marshalls. The amount of fall-out arriving at populated atolls depended upon the proximity of the air particle trajectories to a west-east line through ground zero. Except for BRAVO, the intensity of fall-out was low. The fact remains, however, that the continual deposition of small amounts of long-lived fission products builds up a background which conceivably could result in prohibitive levels causing cessation of testing, or permanent removal of native inhabitants.

(10) Due to mutual interests and over-lapping responsibilities, the close working relation between the Weather Officer and the Radsafe Officer of the task force was a major factor in the successful presentation of sound inter-locking data for operational decisions. To assist this relation and insofar as the possible, the physical locations of the Weather and the Radsafe Sections were adjacent.

b. Weather

(1) The weather, primarily the mid-level (20,000 to 60,000 feet) wind patterns largely determined the schedule of detonations.

(2) Realistic fall-out predictions for high yield weapons required reliable wind forecasts for the first 24 hours following the detonation in order to be assured that significant fall-out could occur within acceptable time and area limitations.

(3) Frequent post-shot wind forecasts should be made during the interval H to H plus 24 hours in order that the actual orientation of fall-out pattern may be more accurately analysed in conjunction with the post-shot weather and radsafe observations.

(4) The frequency and accuracy of pre-shot weather forecasts were adequate for realistic planning and fall-out forecasting following the modification discussed in paragraph 1a (4) above.

(5) Continued research and study of tropical meteorology is required in order to improve long-range wind forecasts.

(6) The employment of constant altitude balloons as a forecasting tool, although not successful on CASTLE due to operational, supply and mechanical difficulties, is still considered a valuable adjunct to the Weather/Radsafe forecasting techniques.

(7) Rawinsonde balloons frequently "iced" and burst at the cold tropical tropopause. As a consequence, critical wind observations were sometimes terminated prior to reaching the maximum significant wind levels.

(8) Due to the tendency of the winds to be westerly at points to the north of ground zero, additional rawinsonde sites in the northwest and northeast quadrants would have been extremely useful.

c. Fall-out forecasting

(1) Assumptions:

(a) As a general rule, the assumptions of 24 hours and 500 nautical miles as the upper limits within which significant fall-out could occur were valid. Although air contamination from water surface shots extends the time to approximately 24 to 30 hours, the aerosol-type cloud from such shots precluded significant fall-out levels at such late times. It appears probable, however, on the basis of available evidence, that a "shine effect"

could be significant for more than 24 hours.

(b) It appears that the altitudes involved in significant long-range fall-out from high yield weapons are 20,000 feet as a lower limit on all types of bursts. 60,000 feet was reasonable upper limit for water surface shots and, 80,000 feet should be considered for land surface shots. The most intense portion of the fall-out apparently comes from the 20,000 to 60,000 feet interval, however, it is noted that the selected limiting altitudes of 60,000 or 80,000 feet may be a function of the atmospheric stability and altitude of the tropopause zone which is latitude-dependent.

(c) Particle sizes down to at least 70 microns, and possibly to 50 microns, apparently contributed to the significant fall-out observed.

(d) The assumption that the fall-out intensities resulting from a water surface shot would be a factor of 10 to 100 less than those of a land surface shot was apparently accurate in part only. Neglecting differences in wind patterns and the fact that three water surface shots were detonated in craters of previous shots, a direct comparison of close-in intensities (within 20 miles from GZ), indicated a rough equivalence for the water versus land types. At greater distances, there was considerable evidence that the aerosol-type cloud of the water surface shot was highly resistant to fall-out and, as a consequence, persisted primarily as a relatively significant aerial hazard for 24 to 30 hours. It is conjectured that the close-in fall-out from the water surface type shot was considerably aided by the scavenging action of large quantities of liquid water, plus some heavy bottom or suspended material, associated with the early close-in fallout.

(e) Prior to the operation, data on surface bursts were

extremely limited, complete documentation of this type burst being confined to one low yield shot at the NPG. The only high yield surface shot (IVY MIKE at the PPG) had not been documented except on the shot atoll itself. CASTLE Radsafe planning was based on the information from these two shots. On the basis of CASTLE radiation measurements, the assignment of actual intensity values to long-range forecast fall-out patterns for high yield shots can now be done with a great deal more confidence.

(f) IVY MIKE early crosswind and upwind iso-intensity values scaled to a chart of BIKINI Atoll reasonably represented (with allowances for yield and shot conditions) the values observed close-in on CASTLE. Also, a new technique developed to determine the initial distribution mathematically was used to some extent and success on the latter part of the series.

(g) The assumption of a circular source of 15-mile radius was adequate for the water surface shots. For the land surface shot, the radius is estimated to have been on the order of 25 miles. Although the true source was assumed to be elliptical with major and minor axes in a ratio of 2:1 to 3:1, a circular sector adequately described the upwind and crosswind spread.

(h) Computed surface RADEXES required a factor of safety applied to the forecast region due to errors in the wind forecast, diffusion of the cloud, initial size of the cloud source and changes in the wind pattern in areas outside the influence of ground zero winds. On CASTLE the addition of a fifteen-degree sector on either side of the computed area was adequate for this purpose.

(i) The effect of yield versus crosswind and upwind spread of contamination over the shot atoll was such that, from a fall-out viewpoint

at least, and assuming equivalent winds, the high yield water surface shots ROMEO, UNION and YANKEE could have been detonated in the IVY MIKE crater at ENIWETOK Atoll.

(2) Wind Pattern Criteria

(a) As a general rule, the winds in the MARSHALL Islands were east northeasterly to easterly in the lower, or trade-wind levels (up to about 20,000 feet) and easterly in the high levels (above tropopause height or at, and above, about 60,000 feet). The mid-levels between were not only variable, but involved the most significant portion of the cloud from a fall-out viewpoint.

(b) Use of two shot atolls imposed further restrictions on shooting due to the effect of a shot at one atoll on the populated areas of the other.

(c) The primary land masses involved in determining the relative favorability of wind patterns were the two shot atolls, UJELANG southwest of ENIWETOK, and the MARSHALL Islands in the southeast quadrant.

(d) Wind patterns acceptable at BIKINI were acceptable at ENIWETOK. The converse was not always true.

(e) For BIKINI shots, mid-level winds from southeast clockwise to southwest were favorable for all types of shots; mid-level winds from east southeast clockwise to west southwest were acceptable for water surface shots. The more southerly the components in these levels, the more favorable the pattern became.

(f) For ENIWETOK shots, mid-level winds from east northeast clockwise to west southwest were favorable for all types of shots; mid-level winds from approximately northeast clockwise to west southwest were

acceptable for water surface shots.

(g) Although wind patterns can develop in which mid-level winds are from favorable directions, the vector summation of the winds must have sufficient southerly component to carry the bulk of the mid-level debris far enough north of ground zero so that crosswind and upwind spread of contamination does not overlap populated areas of the shot atoll.

(h) Trade winds not in excess of 20,000 feet for water surface shots at BIKINI present no fall-out problem for ENIWETOK, and probably no serious problem in the case of land surface shots. Trades in excess of 20,000 feet could be serious for the land burst, and progressively so for water bursts.

(3) Fall-out Forecasting Systems

(a) Forecast systems based on the ground zero winds were useful for close-in fall-out predictions and for RADEX plots valid for periods up to about six hours.

(b) The method of vector summation of the winds as used at previous operations at the NPG and the PPG was inadequate to cope with the significant long-range (beyond about H ≠ 6 to H ≠ 10 hours) fall-out encountered on high yield shots. The major inadequacy of this system, and of all other systems existing prior to the operation, is its complete reliance on the ground zero winds, i.e. on a wind pattern for one geographical location and for a specific time. Originally, this system was extended by a general analysis of the forecast air particle trajectories. Subsequently, the dynamic system of long-range fall-out plotting developed during CASTLE corrected these deficiencies by progressive forecasts for both time and displacement for the first 24-hour period post-shot.

(c) Dynamic systems of forecasting fall-out using air particle trajectory analyses and progressive forecasts of wind patterns in accordance with time and displacement aspects of the cloud, were found to be feasible within the time limitations of an operational decision. Practical methods were divised to apply such a system to the last three CASTLE shots for a valid forecast period of H to H plus 24 hours.

(d) Air RADEX plotting for H to H plus 6 hours was used to advantage to define exclusion areas for operational aircraft and for defining appropriate areas for cloud sampling.

(e) CASTLE data and efforts were sufficient to support profitable interim studies on new forecasting techniques and refinements of current systems for the development of reliable fall-out predictions.

d. Dosimetry

(1) The routine Maximum Permissible Exposure (MPE) of 3.9r for the operation was inadequate, in some cases, for the number and yields of the shots detonated.

(2) The special MPE of 20r for crew members of cloud sampling aircraft was adequate.

(3) In recognition of the inadequacy of the routine MPE, authorization was requested from, and granted by, the Surgeons General of the three Services and by the Director, Division of Biology and Medicine, AEC to revise the MPE through waiver from the Task Force Commander in individually designated cases when circumstances indicated the need and justification therefor. This authority, exercised for a relatively few number of individuals, was adequate for the completion of essential CASTLE missions.

(4) The primary factor in the maintenance of personnel dosages

within established limits was the high degree of Radsafe control exercised over working parties, aircraft and ships operating in contaminated areas.

(5) Personnel dosage control while conducting a completely ship-based operation was extremely difficult for the BRAVO shot, due to the necessity for unusually large numbers of working parties to perform frequent sorties into contaminated areas, the many ships used as housing afloat and the centralization of the film badge processing laboratory facilities on one ship.

(6) Numerical values of limiting criteria for evacuation of task force populations depended upon the stage of completion of the operation, sites and yields of remaining events, and the average level of personnel dosages already acquired. In general, the levels which could be tolerated without evacuation were higher for shots at the end of the series than for earlier shots. As a general rule, a dose rate which would result in two to three times the MPE of 3.9r (and possibly as high as 20r) for the remaining period of the operation was considered acceptable without resorting to the complexity, expense and disruption of an evacuation. Similar values, with a further consideration of life-time dosage aspects, were considered acceptable for native populations.

(7) Considering the high resistence to fall-out exhibited by the aerosol-type clouds from water surface shots, and the unusually rapid "apparent decay" of intensities off-site from shots following BRAVO, a reasonable conclusion could be drawn that a "shine effect" was present for all such shots (and probably for the BRAVO shot as well). Since this effect was not instrumented, it was impossible to assign it a numerical value. Based on meager evidence, however, the "shine effect" was estimated to account for

at least 50% of the dose rate seen during the period of "shine" and fall-out.

e. Radsafe Survey

(1) The plan for cloud tracking to sweep critical areas rather than to follow all segments of the cloud was adequate and well within the capabilities of the aircraft available. Continuous analysis of the raw data received through in-flight reports was the primary method of rapidly determining the relation between forecast and actual particle trajectories. This information, combined with reports from ground monitoring stations, made possible rapid general determinations of fall-out patterns after each shot.

(2) Manned monitor stations on the several islands were very useful to assist the post-shot evaluation of fall-out and to augment the system of aerial radsafe reconnaissance. In some cases the scale range of the radiac instruments was inadequate and was corrected. Although the BRAVO event indicated that more stations were needed, personnel and self-sufficient housing and communications equipment were not available during the shot phase to put them in operation. Also, the absence of critical populations after BRAVO, made such stations less urgent. The existing network of stations, equipped with appropriate instruments and communications facilities, provided a valuable safeguard for populated areas within five hundred miles of the shot site.

(3) The use of routine operational and test aircraft to assist in the definition of fall-out areas on the shot atoll and between ground zero and the task force fleet was inadequate. It was found necessary to divert WB-29 cloud tracking aircraft to make low-level sweeps between the ships and the shot atoll and to assess the physical and radsafe damage to the BIKINI airstrip.

(4) Although the cloud tracking plan included 10,000-foot aerial sweeps up-wind of populated areas on shot day and low-level precision aerial sweeps on shot day plus one, it was found desirable to make low-level passes over the northern MARSHALL Islands on shot day. For this purpose, WP-29 cloud trackers were diverted to over-fly these islands at approximately 200 feet from about H plus 10 to H plus 12 hours for a general estimate of the existing conditions. Since major fall-out could occur within 10 to 12 hours after shot time, the data obtained by these flights gave reasonable and timely assurance to operational decisions relative to the existence of a real hazard at the atolls involved.

(5) Considerable progress was made by scientific projects in defining the fall-out pattern over-water by sampling the water itself and by low-level aerial survey of the contaminated water using sensitive scintillation-type gamma rate meters. The use of raft or buoy fall-out collectors to measure the over-all pattern was generally unsuccessful due to operational difficulties in locating the collectors, and due to losses of collectors arising from failure to locate and from shot delays. The new methods, using a few rafts or buoys to tie in actual numerical values of intensity shows great promise in solving the major fall-out documentation problem for future operations at the PPG.

f. Personnel

(1) The shot phase of an operation of the magnitude of CASTLE requires at least two Radsafe trained officers, at the Task Force level preferably three, and at least three clerical assistants. A full time assistant Radsafe Officer available during the 24-hour period immediately preceding and immediately following each shot would have precluded the requirement for

one such officer remaining excessively on duty without rest. The necessity for preparation of displays, advisories and forecasts and maintaining a periodic Command Briefing schedule through about H minus 3 hours, followed by at least a twelve-hour post-shot period of detailed analysis of the close-in and long-range fall-out aspects of the shot, and the preparation of additional advisories and directives, were not compatible with the assignment of one officer to this duty. Although "additional duty" officer personnel were available to assist during the critical shot days, these people were neither available between shots to carry through on documentation of the shots and preparation of historical material, nor can it be expected that similar personnel will be freely available in the future for even the critical shot days. The amount of between-shot work that could be properly completed was limited. Extensive preparation of documentary and historical material, while still fresh in the minds of the participants, could not be properly accomplished with the available personnel. Further, clerical assistance was adequate only through excessive and frequent after-hours duty.

(2) The shot phase stage of development of the dynamic fall-out plot (par 1 c (3)(c) above) was such that approximately one and one-half to two hours work was required by one man to complete the forecast. Although, this time factor can undoubtedly be improved, the fact remains that, within the time limits available for preparation of material for an operational decision, additional responsible personnel must be available to prepare other material needed for the decision.

(3) The preparation of the dynamic fall-out plot requires the full-time assistance of a weather forecaster familiar with the long range air particle trajectories and with at least the general nature of the fall-

out problems.

(4) The task force Biomedical Advisor and Staff Surgeon was of invaluable assistance to Radsafe due to his special training in radiology and previous field experience on atomic tests.

(5) The principle of command responsibility for Radsafety with self-sufficient Radsafe Units in each of the task groups was sound. The manning of these units primarily with group-trained additional-duty personnel was not only a saving in total numbers of people, but entirely adequate for task group needs. In particular, the principle of project recovery monitor as an additional duty of project personnel, and the organization of a pool of emergency back-up monitors, were outstanding economy factors.

(6) Nuclear Engineers, or equivalent, were assigned to each task group (except TG 7.5) in order to conduct general and specialized group training and to organize task group units capable of carrying out task group radsafe responsibilities.

(7) Due to the unexpected requirement for a completely ship-based operation for the roll-up of the contaminated TARE camp and for simultaneous split-atoll operations, the total numbers of personnel in the Radsafe Unit of TG 7.1 was inadequate.

(8) The number of personnel assigned to the special fall-out program conducted by the Health and Safety Laboratory, New York Operations Office, AEC was such that routine task force support was, at times, inadequate. Occasionally, special arrangements had to be made with available equipment and clerical personnel in order to support the program.

g. Communications

(1) The special voice radio circuit between the Radsafe OFFICE

at the Command Post and the Radsafe CENTER of TG 7.1 was adequate. The special CW station set up in the Radsafe OFFICE and tied into the WB-29 Cloud Tracker and the Weather station net to intercept in-flight radsafe reports and to relay changes in flight track, was the key to the successful accomplishment of the cloud tracking plan. Rapid and accurate means of communication were the indispensible ingredients of all post-shot efforts to assess and analyse the fall-out aspects of the shots.

2. Recommendations:

a. General:

(1) An adequate danger area should be established for future operations at the PPG. Danger Area notices relative to the establishment should be given wide dissemination.

(2) Native populations within 500 miles of the test site should be briefed in advance on the general features of the operation and the general nature of the safety measures to be taken for their protection.

(3) Studies should be made relative to the concentrations of hazardous long-lived fission products on the MARSHALL Islands to the east of BIKINI.

(4) Manned radsafe monitor stations should be provided for at least the northern MARSHALL Islands. Stations should be equipped with roentgen range instruments and with radio communication facilities, and should be in operation from H hour until approximately D plus 3 days. The primary mission of the stations should be to determine and report significant intensities, to obtain the time variation of intensities, and to evaluate "shine effects.

(5) Film badges should be provided for a representative number

of inhabitants of all populated atolls within 500 miles of the shot site. Responsible persons should be selected to wear the badge, or the badges cached on the atolls and as little publicity as possible given to the presence of film badges on the atoll. For standardization, task force facilities should be used for supply and processing of badges.

(6) For lagoon surface operations, reasonable and routine radsafe precautions should be prescribed. In the event of violent storms within several weeks following a detonation, lagoon surface operations should be preceded by an extensive radiological analysis of the lagoon water.

(7) Space, facilities and personnel of the weather and radsafe sections should be physically located to stress maximum cooperation and coordination in the discharge of the mutually over-lapping weather/radsafe functions.

b. Weather:

(1) The health hazard risks which can be introduced by poor fall-out predictions, and the cost of maintaining the entire task force at the PPG extra days due to inaccurate weather forecasts, should be emphasized in their relation to the cost of supporting a small meteorological research staff.

(2) A better constant altitude balloon project should be planned and supported as part of the weather/radsafe services for future operations.

(3) Better rawinsonde balloons, capable of resisting the effects of the cold tropical tropopause, should be obtained for future operations.

(4) Frequent post-shot revised wind forecasts should be issued covering the period of H to H plus 24 hours.

(5) Rawinsonde sites should be established in the northwest and the northeast quadrants.

c. Fall-out Forecasting:

(1) Assumptions: The basic assumptions as used and modified by the CASTLE shots should be used for future PPG operational planning.

(2) Wind Pattern Criteria: The basic criteria as used and modified by the CASTLE shots should be used for future PPG operational planning.

(3) Fall-out Forecasting Systems

(a) Fall-out forecast systems based on ground zero winds as used on CASTLE, should be retained for furture operations, but limited to a valid time of approximately six hours.

(b) The dynamic fall-out forecast system developed on CASTLE should be refined for future operations and the construction technique simplified to reduce its complexity and the time involved in its construction.

(c) The Air RADEX construction technique, as modified for source size on CASTLE, should be used on future operations at the PPG.

(d) Old and new fall-out forecasting techniques in general, should be studied and supported on the basis of CASTLE data, and with considerations similar to those outlined above for meteorological research.

d. Dosimetry:

(1) The Maximum Permissible Exposures, as modified by the waiver provision, should be used for future operations at the PPG.

(2) Personnel dosage control should be made a special subject for task group and unit commanders, and positive measures taken to insure compliance with necessary regulations and controls.

(3) Irrespective of other factors, centralized film badge supply and processing should be retained, and constant efforts made to maintain standardized techniques for the reduction of the many variables involved.

(4) The dosages acquired by native populations from the CASTLE series must be considered in setting up radiation dose criteria for critical MARSHALL Islands on future operations.

(5) The "shine effect" for distances up to 500 miles must be evaluated on future operations for its contribution to total dose and for its possible impact and revision of doses acquired during the CASTLE series.

e. Radsafe Survey:

(1) The CASTLE cloud tracking plan (as modified below) should be re-instituted for future tests, and augmented by manned ground stations spread throughout the MARSHALL Islands.

(2) A special cloud tracker should be planned to perform extensive aerial reconnaissance at various levels in the vicinity of the task force fleet and the shot atoll.

(3) A special cloud tracker should be planned to perform low-level (approximately 200 feet) passes over the northern MARSHALL Islands on shot day. The timing should be such that significant fall-out could have occurred prior to the survey.

(4) Support of CASTLE-developed methods of measuring the ocean fall-out pattern by aircraft and ships, should be given high priority on future tests.

f. Personnel:

(1) The Radsafe Section of the task force headquarters should be augmented during the shot phase by the following personnel:

(a) Two Nuclear Engineers

(b) One clerk typist

(2) One weather forecaster should be made available to the Rad-safe Section of the task force from about H minus 20 hours to about H plus 12 hours to work directly on the preparation of dynamic forecast fall-out plots

(3) The task force headquarters should be augmented during the shot phase of the operation by one medical officer, trained in radiology, and with previous field experience on atomic tests. This officer and the Rad-safe Officer should work in close coordination on matters of mutual interest.

(4) The policy of assigning Nuclear Engineers (or equivalent) to each task group, and the principle of manning Radsafe Units with personnel trained in radsafe as an additional duty, should be retained for future tests.

(5) A large pool (at least 100) of emergency back-up radsafe monitors should be organized for the Radsafe Unit of TG 7.1. Personnel should be drawn from all task groups or units not likely to encounter contamination.

(6) Future plans to support fall-out programs for the Health and Safety Laboratory of the AEC's New York Operations Office should include a practical and substantial number of personnel to assure accomplishment within routine task force support capabilities. The plan should consider the assignment of military personnel to this program in view of the mutual Task Force /CINCPACFLT/Trust Territory/AEC interests, especially in the category of manned stations within 500 miles of the test site.

g. Communications:

(1) Positive two-way radio facilities linking the task force Radsafe Section with the Radsafe Unit of TG 7.1, the cloud trackers and the manned monitor stations should be a high priority requirement on future operations.

TAB "A"

ANNEX N TO CJTF SEVEN OPERATION ORDER NO. 3-53

RADIOLOGICAL SAFETY

1. Radiological safety of all task force military and civilian personnel is a command responsibility and radiological safety activities will be performed through normal command channels.

2. The Commander, Joint Task Force SEVEN will:

a. Specify the measures necessary to insure the radiological safety of task force personnel and furnish technical advisory assistance to task group radiological safety officers.

b. Inform CINCPAC of radiological hazards which may exist in areas outside the task force responsibility.

c. Maintain an information center (RadSafe Office) with displays of current air and surface radexes, radiological situation maps of atolls and peripheral aerial and surface areas and such other allied data as may be appropriate.

d. Arrange for the designation of monitors and couriers to accompany radioactive and special cargo shipments on sample return aircraft and to monitor loading and unloading of such cargo.

3. Task Group Commanders will:

a. Provide radiological safety units within their task groups and insure that these units are in the required condition of readiness to carry out the radiological safety missions of their respective task groups.

b. Provide complete allowances of radiac equipment and special clothing. The requirements of CTG 7.5 will be included in the allowances of CTG 7.1 for necessary issue to TG 7.5 personnel during the operational phase and for subsequent loan or sale to CTG 7.5 for post-operational use at the Pacific Proving Ground.

c. Prior to the first shot minus 10 days, forward to CTG 7.1 (for use of the RadSafe Center in conjunction with film badge radiation dosage control) a listing of task group personnel to whom film badges will be issued during the overseas phase of the operation. Within five days following each shot, provide CTG 7.1 with additions to previous lists. Lists will indicate full name, rank or rate, serial or service number if applicable and home station or laboratory as appropriate.

4. The Commander, TG 7.1, having the major technical radiological safety unit, will:

a. Perform all ground monitoring services associated with scientific missions except those in conjunction with aircraft and airborne collection of scientific data.

b. Provide laboratory services and technical assistance to all task groups, to include:

(1) Provision of standard type film badges and specified supplementary items of personnel radiological safety equipment.

(2) Laboratory services to develop and interpret film badges.

(3) Records of exposures from film badges. (Duplicates will be furnished task group commanders).

(4) Laboratory services for the radiochemical analysis of water samples.

(5) Provision of primary facilities at PARRY ISLAND radiological safety building for calibration, repair and maintenance of instruments and storage of spare parts of radiac equipment. Similar limited facilities will be maintained at BIKINI during the operational phase at that atoll.

(6) Monitoring the removal and packaging of radioactive sources and samples except, as indicated in paragraph 4a above, removal operations from aircraft will remain the radiological safety responsibility of the task group to which the aircraft are assigned.

c. Provide radiological safety surface situation maps after shot times to the task force and task group commanders.

d. Provide and issue special high density goggles to specified personnel of the task force.

e. Provide and maintain radiac equipment and protective clothing as necessary for TG 7.1, TG 7.5 and specified recovery personnel.

f. Provide technical personnel to assist task group commanders in the inspection of radiologically contaminated items and the certification of destruction, disposal or unserviceability of such items as required.

g. Maintain a radiological safety center (RadSafe Center) for the control of TG 7.1 radiological safety operations.

h. Provide personnel and equipment decontamination facilities for radiological safety survey and recovery operations.

i. Perform limited fall-out studies within the Pacific Proving Ground for radiological safety documentation only.

j. Assume radiological safety responsibilities of TG 7.5 during the overseas phase of the operation.

k. Integrate within TG 7.1 key radiological safety personnel made available by CTG 7.5. Such personnel will assist CTG 7.1 during the operational phase and will be assigned duties amenable to training in the fundamental radiological safety services to be assumed by CTG 7.5 upon completion of the overseas phase of the operation.

l. Assist CTG 7.3 to the extent of providing equipment, personnel and supervision for rough operational decontamination of aircraft ashore at BIKINI ATOLL. Decontamination will be limited to washdown of exterior and vacuum cleaning of interiors. No detailed decontamination will be attempted by TG 7.1 personnel. Aircraft crews

will assist in this operation.

5. The Commander, TG 7.2 will:

a. Perform all ground monitoring services associated with ENIWETOK ISLAND except in those areas or activities assigned to other task groups.

b. Provide own radiological safety monitors, fifty (50) of which will be "Q" cleared for emergency monitor support of TG 7.1 if required.

c. Provide own decontamination personnel, ten (10) of which will be designated for emergency decontamination support of TG 7.1 if required.

d. Provide own radiac equipment and protective clothing.

e. Provide own repair, spare parts and calibration facilities for radiac equipment.

f. Provide contaminated clothing laundry facilities for TG 7.4.

g. Provide contaminated equipment storage area with the necessary security.

6. The Commander, TG 7.3 will:

a. Provide own radiological safety monitors, including one airborne monitor for each multi-engine aircraft crew assigned to TG 7.3.

b. Provide own radiac equipment and protective clothing.

c. Provide own repair, spare parts and calibration facilities for radiac equipment.

d. Provide monitors and decontamination crews aboard each ship within the task group.

e. Provide facilities for personnel decontamination on the CVE.

f. While the task force is embarked, provide space for use of the radiological safety unit (RadSafe Center) of TG 7.1.

g. Provide decontamination crews and facilities for all aircraft at BIKINI ATOLL. Limited assistance ashore will be furnished by CTG 7.1 in accordance with paragraph 4ℓ, as required.

h. Provide decontamination crews and facilities for own aircraft aboard the CVE at ENIWETOK ATOLL. Limited assistance ashore will be furnished by CTG 7.4, as required.

i. Provide necessary helicopter air service for radiological surveys and post-shot recovery operations (monitors furnished by TG 7.1).

j. Collect lagoon water samples.

k. Provide water spray equipment aboard all vessels likely to be in the fall-out area.

l. During the BIKINI phase provide for air to gr[illegible] reporting of approximate air radiation intensities encountered by all aircraft operating between ENIWETOK and BIKINI from H Hour to H plus 24 hours. It is not contemplated that aircraft should be scheduled for this specific requirement alone. Reports will be routed to the RadSafe Office at the task force command post by the most expeditious means. Reports will be prepared and coded in accordance with paragraph 7*l*, below.

7. - The Commander, TG 7.4 will:

a. Provide own radiological safety monitors, including one airborne monitor for each multi-engine aircraft crew assigned to TG 7.4.

b. Provide own radiac equipment and protective clothing.

c. Provide own repair, spare parts and calibration facilities for radiac equipment.

d. Provide facilities for personnel decontamination on ENIWETOK ISLAND.

e. Provide decontamination crews and facilities for own aircraft at ENIWETOK ATOLL.

f. At ENIWETOK ATOLL, assist TG 7.3 in aircraft decontamination with TG 7.4 equipment, as required.

g. Provide necessary helicopter and liaison air service for radiological surveys and post-shot recovery operations (monitors furnished by TG 7.1).

h. Provide monitoring services for the removal (by TG 7.1 personnel) of radioactive samples or data collected by aircraft.

i. Provide cloud tracking aircraft for post-shot radiological safety "situation data" up to radius of 500 miles in the significant quadrant for a period of 48 hours, starting at approximately H plus 6 hours. Reports will be prepared and coded in accordance with paragraph 7*l*, below.

j. During the BIKINI phase, provide for air to ground reporting of approximate radiation (air) intensities encountered by all aircraft operating between ENIWETOK and BIKINI from H Hour to H plus 24 hours. It is not contemplated that aircraft should be scheduled for this specific requirement alone. Reports will be routed to the RadSafe Office at the task force command post by the most expeditious means. Reports will be prepared and coded in accordance with paragraph 7*l*, below.

k. Employ simple codes (to be furnished separately by CJTF SEVEN) in conjunction with the periodic weather reconnaissance reports to report approximate air radiation intensities encountered on regularly established weather reconnaissance or cloud tracking flights and for reports required from aircraft operating during the BIKINI phase between ENIWETOK and BIKINI from H Hour to H plus 24 hours. Reports will indicate the approximate position, altitude and order of magnitude of radiation encountered.

l. Develop the air RADEX for each shot.

8. The Commander, TG 7.5 will:

a. Develop a schedule of requirements for radiological safety services required from CTG 7.1 and assist CTG 7.1 in decontamination of AEC facilities and equipment as necessary.

b. Provide key radiological personnel for integration into and training with the radiological safety organization of TG 7.1 during the overseas phase of the operation. The total number and qualifications of such personnel will be as determined necessary by CTG 7.5, commensurate with the assumption of responsibilities indicated in paragraph 8c, below.

c. Assume residual task force radiological safety functions at the Pacific Proving Ground upon completion of the overseas phase of the operation. Required equipment and supplies will be made available at that time to CTG 7.5 on a loan or sale basis from stocks provided by CTG 7.1.

P. W. CLARKSON
Major General, U.S. Army
Commander

Appendix

I - Radiological Safety Regulations
II - Radiological Safety Office and Center
III - Hazards Resulting from Atomic Bomb Explosions

OFFICIAL:

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RADIOLOGICAL SAFETY REGULATIONS

1. General

a. Radiological Defense (RadDefense) operations or Radiological Safety (RadSafe) operations, short term RadOps, are general terms. They are used to denote the means by which a unit can control and confine the damage and radiological effects of an atomic explosion or of radioactive material spread by other means, thereby preventing and avoiding health hazards to personnel. They are interpreted to include measures such as training, organization, distribution of radiological personnel, development of techniques and procedures, use of detecting equipment, protection or removal of exposed personnel and decontamination of personnel, structures and equipment.

b. Following each detonation there will be areas of surface radiological contamination and areas of air radiological contamination. These areas are designated as Radiological Exclusion Areas (RADEX). Prior to shot times, the forecast air and surface RADEX will be disseminated by CJTF SEVEN in the target area. These RADEXES will represent a forecast from H Hour until dissemination of a later surface and air RADEX at about H plus 4 hours. The later RADEXES will be based upon the master radiological "situation map" maintained in the RadSafe Office of CJTF SEVEN. Since the air RADEX after shot times will be based on monitored tracking by aircraft over significant large ocean areas, information promulgated from the forecast air RADEX may have to be extended beyond the originally anticipated 4 hour period.

c. The surface RADEX will be determined by actual survey with Radiation Detection, Indication and Computation (RADIAC) equipment after shot time. The most rapid method of accomplishing surface survey in the early stages will be by helicopter flight in and around the surface of contaminated areas. From the radiation intensities measured at a known altitude, it is possible to obtain an estimate of the radiation dosage rates which would be encountered on the surface of the ground or water. Actual water samples from the lagoon will also be utilized. Ground survey will follow these guides to determine definitely the contaminated regions and objects. Formal ground survey of the shot atoll, as feasible, will be accomplished on H plus 24 hours.

2. The Maximum Permissible Exposures (MPEs) and Maximum Permissible Limits (MPLs) as stated herein are applicable to a field experimental test of nuclear devices in peacetime wherein numbers of personnel engaged in these tests have been previously exposed or will be continuously exposed to potential radiation hazards. It may become necessary from a study of personnel records to reduce the MPE for certain individuals who have recently been over-exposed to radiation. Further, the MPEs and MPLs are subject to revision by waiver from the task force commander in individually designated cases when circumstances indicate the need and justification therefor.

3. Due to the special nature of field tests it is considered that a policy of strict adherence to the radiological standards prescribed

for routine work is not realistic. The regulations set forth herein have been designed as a reasonable and safe compromise considering conservation of personnel exposures, the international import of the test and the cost aspects of operational delays chargeable to excessive radiological precautions. In all cases other than emergencies or tactical situations the ultimate criteria will be limited by the MPEs for personnel. Special instances may arise such as in the case of an air-sea rescue within the RADEX or in the case of tactical situation in which operations will be carried out without regard to the MPEs and MPLs prescribed herein. For such emergency or tactical operations the criteria prescribed below for tactical situations will be used as a guide. Wherever possible, however, film badges will be carried and RadSafe monitors will accompany such operations to determine the extent of the actual radiation hazard experienced in order that appropriate medical action may be initiated.

4. Task force radiation dosage control will start on first shot minus fifteen (15) days and terminate upon departure of individuals from the forward area or on the last shot plus fifteen (15) days, whichever occurs first. All personnel will be considered to have arrived at the Pacific Proving Ground by first shot minus fifteen (15) days. Prior and subsequent to this period, radiation dosage control will be as prescribed by CTG 7.5.

5. a. The MPE for personnel involved in this operation, as defined by paragraph 4, above, is 3.9 roentgens (gamma only). This exposure may be acquired at any time during a thirteen (13) week period of the operation. Provided no previous over-exposure remains for compensation, 3.9 roentgens may be acquired without regard to the individual's past radiation history. This MPE will be considered further augmented (without separate action) by 0.3 roentgens per week for each week in excess of thirteen (13) weeks required during the operational period defined by paragraph 4, above.

   b. A special MPE of 20 roentgens (gamma only) is authorized for the operational period as defined by paragraph 4, above, for crew members of air sampling aircraft.

   c. All exposure to external gamma radiation will be regarded as total body irradiation.

6. Those individuals exposed to ionizing radiation in excess of the value computed by paragraph 5a, above, will be informed that appropriate remarks will be included in their medical records. Military personnel in this category will be advised that they should not be exposed to further radiation until sufficient time has elapsed in order to bring their average radiation dose down to 0.3 roentgens per week. Civilian personnel in this category will be informed that limitations on further radiation exposure will be as determined by the laboratory or agency having administrative jurisdiction over such personnel.

7. All atoll land and lagoon areas in or near which a detonation takes place will be considered contaminated until cleared for operations by the task force commander. Entry to and exit from contaminated areas will be via RadSafe check points only.

8. Contaminated land and water areas will be delineated as such. Personnel entering these areas will be subject to clearances by the

RadSafe Office, TG 7.1, and will normally be accompanied by a RadSafe monitor. RadSafe clothing and equipment will be issued to the personnel.

9. Contaminated land areas of intensities less than 10 mr/hr (gamma only) will be considered unrestricted from a RadSafe standpoint. Areas coming within this limitation will be designated specifically by CJTF SEVEN prior to unrestricted entry.

10. RadSafe monitors assigned to individuals or groups working in contaminated areas or with contaminated equipment during recovery operations will act in an advisory capacity to keep the recovery party leader informed of radiation intensities at all times. The recovery party leader is expected to accept this advice and act accordingly. It is the responsibility of both the leader and the members of the recovery party to adhere to the limits established in these regulations. The RadSafe monitor will limit his activities to monitoring and will not engage in actual recovery operations.

11. Film badges, dosimeters and protective clothing (coveralls, booties, caps, gloves, dust respirators, etc.) as deemed necessary will be issued to personnel entering contaminated areas by appropriate task group RadSafe supply sections. All personnel dosage film badges will be procured from and returned to the laboratory of TU 7, TG 7.1, where all processing and recording will be accomplished.

12. All personnel within viewing distance of an atomic detonation who are not supplied with protective goggles will turn away from the detonation point and close their eyes during the time of burst. At least 10 seconds should be allowed before looking directly at the burst.

13. The arrival and proposed use of radioactive sources at the Pacific Proving Ground will be reported to the RadSafe Officer of TG 7.1.

14. Transportation of radioactive material to and from the forward area shall be in accordance with AEC regulations for escorted shipment of such material. The assignment of couriers and RadSafe monitors will be the subject of separate instructions. No radioactive material shall be removed from the test site except as authorized in experimental projects.

15. All samples of radioactive material which are couriered in aircraft will be packaged and loaded so as to reduce radiation to a minimum. Prior to departure of such aircraft, the RadSafe Officer, TG 7.4, will have a survey made of the aircraft cargo to determine if adequate precautions have been taken. The following criteria will determine space and packaging requirements:

a. Prior exposure of aircraft crew, courier and passengers.

b. Anticipated future exposures on trip, considering length of trip, compartmental loading requirements and capability to isolate personnel from radioactive material.

16. All air and surface vehicles or craft used in contaminated areas will be checked through the appropriate task group decontamination section upon return from such areas.

17. The MPLs listed herein are to be regarded as advisory limits for control under average conditions. All readings of surface contamination are to be made with Geiger counters, with tube walls not substantially in excess of 30 mg/cm^2 with shield open unless otherwise specified. The surface of the probe should be held one (1) inch to two (2) inches from the surface that is under observation unless otherwise specified. For operational purposes the contamination MPLs presented below will not be considered applicable to spotty contamination provided such areas can be effectively isolated from personnel.

a. Personnel and Clothing MPLs

(1) Skin readings should not be more than 1.0 mr/hr. Complete decontamination by bathing will be utilized for readings in excess of this level. If the body is generally contaminated and especially if contamination is on the eyes or gonads, special efforts should be made to reduce the contamination level. In general, however, it is not considered profitable to abrade the skin or epilate the scalp in an attempt to reduce stubborn contamination below 1 mr/hr (about 1000 cpm). Beta radiation exposure to the hands should not exceed 30.0 rep for the operational period, as defined in paragraph 4, above.

(2) Underclothing and body equipment such as the internal surfaces of respirators should be reduced to 2 mr/hr.

(3) Outer clothing should be reduced to 7 mr/hr.

b. Vehicle MPLs. The interior surfaces of occupied sections of vehicles should be reduced to 7 mr/hr. The outside surfaces of vehicles should be reduced to less than 7 mr/hr (gamma only) at five (5) or six (6) inches from the surface.

c. Ship and Boat MPLs

(1) It is desired to point out that the employment of the ships and units in TG 7.3, insofar as radiological safety is concerned, is not considered routine usage within the purview of NavMed P-1325, "Radiological Safety Regulations". Current revision of NavMed P-1325 indicates that its provisions do not apply for special operations such as field tests and that for such operations naval personnel will operate under regulations set forth by the task force commander as approved by the Chief of Naval Operations.

(2) In general, ships and boats operating in waters near shot sites after shot times may become contaminated. Monitors shall be aboard all such craft operating after shot time, either as passengers or members of the crew, until such time as radiological restrictions are lifted.

(3) Task group commanders will take necessary action to ensure that personnel of ships and boats are not over-exposed to radiation and that ships and boats are not contaminated excessively. The criterion in both cases is that no personnel will be over-exposed as defined by paragraph 4a, above, except in emergencies or tactical operations, and that after the operational period no personnel will receive more than 0.3 roentgens per week from contaminated equipment.

(4) For ships and boats operating in contaminated waters, reasonable allowances will be made to differentiate between the relative

contribution to the total flux from fixed contamination and that due to "Shine" from contaminated waters. Fixed alpha contamination should not exceed 2500 dpm(disintegrations per minute) per 150 cm^2 of area for enclosed areas (cabins, etc.) and 5000 dpm per 150 cm^2 area for open surfaces where ventilation is good.

(5) At the conclusion of the operation, final clearances will be granted by task group commanders or by commanding officers, if so ordered, to those ships and boats showing no point of contamination greater than 15 mr/day (beta and gamma) and no detectable alpha. Other ships and boats will be granted operational clearances by task group commanders or by commanding officers, if so ordered. An operational clearance implies that contamination exists and that special procedures as necessary are instituted aboard ship.

(6) Individuals on board ships of the task force shall be protected collectively from hazards of blast, heat and radioactivity by movement and positioning of the ships.

(7) No ships with personnel shall be permitted inside the 1.5 p.s.i. line unless specifically directed otherwise. Bearings of danger from immediate radioactive fall-out for ship operations will be established by CJTF SEVEN on the basis of forecast wind directions at the intended time of detonation. This danger section will be designated as surface RADEX. All ships of the task force shall be required to remain outside the RADEX - danger bearing, radial limitation and time restriction unless specifically directed otherwise. However, if ships are directed tactically into the surface RADEX, movement of ships shall be governed by tactical exposure guides.

d. Aircraft MPLs

(1) The interior surfaces of occupied sections of aircraft should be reduced to 7 mr/hr.

(2) No aircraft in the air at H Hour will be at slant ranges from ground zero less than as determined by the following effects unless specifically directed otherwise. (Based on maximum predicted yield and 20 mile visibility).

Blast (at predicted shock arrival): 0.5 p.s.i.
Thermal (H Hour): Fabric control surfaces: 1.0 cal/cm^2
Metal control surfaces: 6.0 cal/cm^2

(3) After detonation no aircraft shall operate inside the air RADEX or closer than 10 nautical miles from the rising or visible cloud unless specifically directed otherwise. Non-excepted aircraft involved in routine operations encountering unexpected regions of aerial contamination will, immediately upon detecting such contamination, execute a turnout. Cloud tracking aircraft will execute turnout from contaminated areas at a level of not more than 3.0 r/hr. If a tactical or emergency situation arises where aircraft must enter the air RADEX or visible cloud, tactical exposure allowances shall apply.

(4) All multi-engine task force aircraft in the air at H Hour within 100 miles of the detonation point shall carry a person designated as radiological safety monitor, equipped with suitable radiac equipment and a RADEX plot. This monitor shall be capable of

calculating allowable exposures under both tactical and operational conditions.

(5) All persons in aircraft at shot time or at subsequent times when engaged in operations in or near the cloud or RADEX track shall wear film badges.

(6) Crew members of aircraft in the air at zero hour will take special precautions to avoid (for at least 10 seconds) the direct and reflected light resulting from the burst. At the discretion of the airplane commander this could be done with protective high density goggles, by turning away from the burst with eyes closed, by covering the eyes with the forearm, by turning cockpit lights up to highest intensity or by any combination of the above.

e. In air and water the following continuous levels of radioactivity are considered safe from the standpoint of personnel drinking and breathing (uc = microcurie):

	Beta-Gamma Emitter
Water	5×10^{-3} uc/cc (calculated to H $\neq$ 3 days)

Air (24 hour average)
Particles less than 5 micron diameter 10^{-6} uc/cc
Particles greater than 5 micron diameter 10^{-4} uc/cc

18. In tactical situations the military commander must make the decision regarding allowable exposures. As military personnel are normally subject to only randum exposure, health hazards are at a minimum. Current Department of Defense information on exposure to gamma radiation in tactical situations is indicated below:

a. Uniform acute (immediate) exposure of 50 roentgens to a group of Armed Forces personnel will not appreciably affect their efficiency as a fighting unit.

b. Uniform acute exposure of 100 roentgens will produce in occasional individuals nausea and vomiting but not to an extent that will render Armed Forces personnel ineffective as fighting units. Personnel receiving an acute radiation exposure of 100 or more roentgens should be given a period of rest and individual evaluation as soon as possible.

c. Uniform acute exposure of approximately 150 roentgens or greater can be expected to render Armed Forces personnel ineffective as troops within a few hours through a substantial incidence of nausea, vomiting, weakness and prostration. Mortality produced by an acute exposure of 150 roentgens will be very low and eventual recovery of physical fitness may be expected.

d. Field commands should, therefore, assume that if substantial numbers of their men receive acute radiation exposures substantially above 100 roentgens there is a grave risk that their commands will rapidly become ineffective as fighting units.

e. Internal radiation hazards caused by entry of radioactive substances through the mouth, through the lungs or through cuts or wounds do not exist after an air burst. Internal hazards following a contaminating surface explosion may be avoided if ordinary

precautions are taken. Only under unusual circumstances will there be internal hazard from residual contamination. This eliminates the necessity for masking and consequent reduction of tactical efficiency.

19. The RadSafe Officer, TG 7.1, will maintain standard type film badge records of radiation exposures for all task force personnel. Records will indicate full name, rank or rate, serial or service number, if applicable, organization, home station or laboratory, date of exposure, approximate duration of over-exposure in hours and minutes (for Army personnel only) and remarks such as limitations on assignment because of over-exposure. Upon completion of the operation, disposition of these records will be as follows:

a. A consolidated list of exposures listing military personnel and civilian personnel under military control by full name, rank or rate, serial or service number (if applicable), organization, home station or laboratory and exposure in milliroentgens, together with exposed film badges and control film badges, will be forwarded to the Chief, AFSWP.

b. A consolidated list of personnel and exposures as indicated in paragraph 19a, above, including all AEC personnel, will be forwarded to the Director, Division of Biology and Medicine, AEC.

c. Individual records of Navy and Air Force military personnel and civilian personnel will be forwarded to their unit of permanent assignment for inclusion in the individual's health record (Medical History Sheets, NavMed H-8 and the Individual Health Record for Navy and Air Force personnel, respectively). For these military personnel exposed to ionizing radiation in excess of that defined in paragraph 5a, above, a statement will be included to the effect that the individual is not to be subjected to ionizing radiation before a specific date, the date to be computed by the RadSafe Officer, TG 7.1, to allow sufficient time to elapse in order to bring the average radiation dose down to 0.3 roentgens per week. Limitations on Navy and Air Force civilian personnel with reference to over-exposures will be as determined by the laboratory or agency having administrative jurisdiction over such personnel.

d. Individual records of Army military and civilian personnel will be forwarded in accordance with SR 40-1025-66 dated 21 April 1953 to their unit of permanent assignment for inclusion in the individual's field military 201 file or the civilian personnel 201 file (whichever is applicable). These records will indicate date of exposure, amount of exposure in milliroentgens, approximate duration of over-exposure in hours and minutes and a space for remarks such as limitations on assignment (as indicated in paragraph 19c, above) because of over-exposures.

e. Individual records of AEC controlled and administered civilian personnel will be processed in accordance with special instructions prescribed by the laboratory or agency having administrative jurisdiction over such personnel.

f. Upon completion of provisions of paragraph 19a, b, c, d and e, above, letter reports will be submitted through channels to the Surgeon General, USA; the Chief, Bureau of Medicine and Surgery, USN; the Surgeon General, USAF and the Director, Division of Biology

and Medicine, AEC, indicating, in general, the action taken to dispose of individual dose records, comments on over-exposures if applicable and any pertinent remarks considered of interest to the above offices.

20. Training. The inclusion of radiological safety organizations throughout the task force will require two general levels of training; basic indoctrination and technical training. The scope of instruction within each of these levels will vary in accordance with the requirements of different operational and staff levels. Basic indoctrination will include primary, non-technical instruction in radiological safety measures and techniques. This must be imparted to all personnel of the task force to enable them to perform their assigned duties efficiently within the allowable low exposures, regardless of the presence of radioactive contaminants. Technical training will include the training of the majority of the personnel who will be required to staff the task force radiological safety organizations and perform the technical operations involved. This will be accomplished through the utilization of existing Service courses and establishment of suitable courses at task group level. This instruction will be designed to train radiological defense monitors, decontamination personnel and radiological instrument repairmen.

21. These regulations have the concurrence of the Surgeon General, USA; the Chief of Naval Operations; the Surgeon General, USAF and the Director, Division of Biology and Medicine, AEC.

22. This appendix has been designed for reduced security classification in order to facilitate wide dissemination and may be downgraded to RESTRICTED - SECURITY INFORMATION provided all references to Joint Task Force SEVEN and its subordinate units are deleted.

P. W. CLARKSON
Major General, U.S. Army
Commander

OFFICIAL:

Wm S. Cowart, Jr.
WILLIAM S. COWART, JR.
Colonel, U.S. Air Force,
Assistant Chief of Staff, J-3

RADIOLOGICAL SAFETY OFFICE AND CENTER

1. A JTF SEVEN radiological safety office (RadSafe Office) and a TG 7.1 radiological safety center (RadSafe Center) will be established for each shot. The RadSafe Office, manned by personnel of the Technical Branch of the task force Operations Division (J-3), will operate as the task force staff agency responsible for the dissemination of task force radiological directives, the presentation of radiological shot briefing material and the maintenance of displays of radiological information having an impact on the overall task force mission. The RadSafe Center will be established by CTG 7.1 and will serve as operations headquarters for the radiological safety activities of TG 7.1. Pertinent data collected at the RadSafe Center will be forwarded to the RadSafe Office at the task force command post.

2. Detailed Duties

a. RadSafe Office

(1) The RadSafe Office, in coordination with CTG 7.4 who will develop the air RADEX plot, will assemble the overall RADEX situation and disseminate the air and surface RADEX prior to shot time (forecast) and will originate messages from time to time after shot time announcing R (Reentry) Hour, radiological clearances of previously closed areas, radiological directives to task groups, advisories to commands external to the task force and revisions of the air and surface RADEX as required.

(2) The RadSafe Office will be responsible for the preparation of RadSafe forecast information for the shot briefings.

(3) The RadSafe Office will maintain displays of radiological information pertinent to the test area and having an impact outside this area to include radiation levels on atoll islands and lagoon, RADEX information, cloud trajectories and their relation to occupied atolls and air and surface routes contiguous to the danger area, ship movements in the danger area, results of water sampling and such other items of special radiological consideration as may be required by the operation or the scientific projects.

(4) Physical Locations of RadSafe Office

a. For BIKINI ATOLL shots: Command ship

b. For ENIWETOK ATOLL shots: Operations Division (J-3), JTF SEVEN Headquarters building, PARRY ISLAND.

b. RadSafe Center

(1) The RadSafe Center will maintain radiological situation data on lagoon waters and islands of the shot atoll, based on air and ground survey information, supplemented by monitor reports. This information will be the basis of periodic situation reports or maps and briefing information furnished to the task force and task group commanders.

(2) The RadSafe Center will provide information for the planning of TG 7.1 radiological safety operations and for the disposition of all working parties within the contaminated area. It will establish radiological safety check points. It will maintain an operations table giving details for all groups who plan to enter contaminated areas each day, including name of monitor, destination, general type of mission (program or project number) and time of departure and return.

(3) The RadSafe Center will provide special clothing to previously designated recovery personnel, have cognizance over working schedules of the radiochemical laboratory, photodosimetry developing facilities, contaminated laundry, personnel decontamination facilities, radiac repair, etc. of TG 7.1. Personnel decontamination facilities afloat will be coordinated with existing ship facilities.

(4) Physical Locations of RadSafe Center

a. For BIKINI ATOLL shots: The RadSafe Center will initially operate from the CVE facilities. At a later time, radiological conditions permitting, the center will provide a detachment at pre-prepared positions ashore to operate all its activities except radiochemistry and photodosimetry.

b. For ENIWETOK ATOLL shots: The RadSafe Center will operate all of its facilities from the radiological safety building on PARRY ISLAND (Building 57).

P. W. CLARKSON
Major General, U.S. Army
Commander

OFFICIAL:

WILLIAM S. COWART, JR.
Colonel, U.S.Air Force,
Assistant Chief of Staff, J-3

Appendix III to Annex N
Radiological Safety, CJTF SEVEN Operation Plan No. 3-53

HAZARDS RESULTING FROM ATOMIC BOMB EXPLOSIONS

1. Nature of Hazards

a. When an atomic bomb explosion occurs, tremendous quantities of energy in a variety of forms are released. This energy is propagated outward in all directions.

b. The immediate reaction is intense emission of ultraviolet, visible and infrared (heat) radiation, gamma rays and neutrons. This is accompanied by the formation of a large ball of fire. A large part of the energy from the explosion is emitted as a shock wave. The ball of fire produces a mushroom-shaped mass of hot gasses, the top of which rises rapidly. In the trail below the mushroom cap, a thin column is left. The cloud and column are then carried downwind, the direction and speed being determined by the direction and speed of the wind at the various levels of air from the surface to base of mushroom cap. Part of the energy from the explosion results in an ocean surface wave which is considered of minor nature directly to the task force.

c. All personnel of the task force will be well outside of the range of all hazard at the time of detonation, except for the light from the fire ball. The light of explosion is so intense that permanent injury to the eye may result from viewing the ball of fire at close range with the naked eye or through binoculars. Ordinary dark glasses will not suffice and all personnel who do not have the special protective glasses, which will be issued in limited numbers by TG 7.1, must be facing 180 degrees from the detonation with the eyes closed.

d. The emission of dangerous nuclear radiation can be separated into two time periods. The primary radiation which occurs at the time of the flash is composed of gamma rays and neutrons. Casualties may result from this primary radiation if the exposure occurs within a certain range of ground zero. Secondary radiation is due to activation of the soil around ground zero and to fall-out.

e. Following the detonation, personnel entering shot areas will be exposed to beta particles and gamma rays coming from induced neutron activity in the soil and any fission products which might have been deposited on the ground. There may also be a potential alpha particle hazard from the unfissioned fissionable materials which may be deposited on the ground.

2. Protection

a. Against the primary radiological effects, distance will provide protection.

b. Against the secondary radioactivity hazards from radioactive fission products, induced radioactivity and unfissioned residue, detection and avoidance provide the best protection. Suitable instruments indicate both the presence and intensity of radioactivity at a given place. Area reconnaissance, the maintenance of contamination

situation maps, the posting of areas of hazard [illegible] minimizing the spread of contaminated material into uncontaminated areas constitute the active measures for reducing the radiological hazard.

c. Personnel within an operational radius of ground zero who are to be facing in the direction of the flash will be required to wear special goggles to protect their eyes against excessive light. Personnel within the above operational radius who are not provided goggles will face, with eyes closed, in the opposite direction from the flash. After ten (10) seconds, such personnel may turn around and observe the phenomena.

3. Anticipated Hazard Areas

a. Immediately under the bomb burst there will be an area of intense radioactivity extending downwind and, to some extent, crosswind and upwind with gradually decreasing intensity.

b. Extending downwind, and to some extent, crosswind and upwind) an airborne radioactive hazard will exist. Its characteristics will depend on the meterological influences such as wind speed and direction at various altitudes up to the maximum height reached by the cloud.

c. Contaminated water in the lagoon adjacent to the shot site may be of consequence and will be analyzed by the radiological safety unit of TG 7.1 immediately after shot time and at other intervals.

d. Unless care is exercised, individuals or objects entering contaminated areas may transfer radioactivity to clean areas.

e. By means of instruments such as Geiger-Mueller counters and ion chambers it is possible to detect the area of contamination and to measure the intensity of the radioactivity. Radiation intensity will normally be measured and reported in roentgens per hour. Besides those instruments, dosimeters and film badges will be used as indicators of the accumulated exposure to radioactivity. Only personnel involved in work near, or in, radioactive areas will wear film badges to provide a permanent record of exposure, except that film badges will be issued to ten (10) percent of ship crews to aid in estimating crew dosage in the event of heavy fall-out.

f. The intensity of the radioactive hazard tends to decrease with time due to decay of radioactive materials and dispersion and dilution, depending upon climatic conditions. As an approximation, the intensity of the surface contamination from the fission products decreases by radioactive decay inversely with the time after the detonation. As a further approximation, the intensity of water contamination decreases by radioactive decay and diffusion inversely with the square of the time after the detonation.

4. This appendix has been designed for reduced security classification in order to permit wide dissemination to all personnel of the command and may be downgraded to RESTRICTED - SECURITY INFORMATION provided all references to Joint Task Force SEVEN and its subordinate units are deleted.

OFFICIAL:

WILLIAM S. COWART, JR.
Colonel, U.S. Air Force,
Assistant Chief of Staff, J-3

P. W. CLARKSON
Major General, U.S. Army
Commander

TAB "B"

Headquarters, JTF SEVEN Special Operating

Procedure 30-2, Waiver of MPE

2 Incls:
1. Request for Waiver of MPE - Form
2. Para 2, SO 87, Hq, JTF SEVEN, 4 June 1954

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

STANDING OPERATING PROCEDURE) NUMBER 30-2)

15 February 1954

PERSONNEL

Waiver of Maximum Permissible (Radiation) Exposure (MPE)

1. PURPOSE. This SOP prescribes the procedure to be followed in the submission of requests for waiver of Maximum Permissible (Radiation) Exposure (MPE).

2. SCOPE. This SOP applies to this headquarters and to each Task Group.

3. POLICY. With the concurrence of the Surgeon General, USA; CNO and the Chief, Bureau of Medicine and Surgery, USN; the Surgeon General, USAF; and the Director, Division of Biology and Medicine, AEC, CJTF SEVEN will take final action on requests for waiver of MPE for work accomplished at the Pacific Proving Grounds for all individuals assigned or attached to Joint Task Force SEVEN. Requests for waivers will be considered and resolved in accordance with the following:

a. Basic premises.

(1) Authority for granting a waiver will not be re-delegated except, in the absence of CJTF SEVEN, to individuals in the capacity of Acting Commander, Joint Task Force SEVEN.

(2) Waiver of the MPE will be used as an emergency measure only.

(3) The need and justification for the waiver of MPE will be determined on the basis of the technical import and the medical aspects of the proposed work for which the waiver of MPE is requested. This determination will be based upon the recommendations of the Scientific Director, JTF SEVEN, and the Biomedical Advisor and Staff Surgeon or, in the absence of the above, their designated representatives.

(4) Approval of request for waivers will be in terms of authorization to complete a job associated with one specific shot. Utilization of individuals on subsequent shots where exposure to radiation will be expected, will require additional request for waiver. It is the responsibility of the project officer and individual concerned to complete the work with the minimum exposure.

b. Forms and Routing.

(1) Requests for waivers of MPE will be in writing and on the form attached hereto. Normally, requests for waiver will be submitted by the project officer, or equivalent, of the individuals requiring waiver action. The request will list each individual by name for whom the waiver is to apply, however, the justification for the waiver may be general in application to the entire group. Requests for waiver by individuals other than the individual for whom the waiver is to apply, will contain the following statement: "This request for waiver of the MPE is submitted on behalf of, and has the concurrence of, the individual(s) named below."

(2) This SOP will not preclude verbal approval of a waiver in the interest of expediency, however, supporting papers will be accomplished for the formal record.

(3) Requests for waiver will be submitted to CJTF SEVEN through the Radiological Safety units of the respective task groups and this headquarters. Task Force and Task Group Radiological Safety Officers will act in the capacity of recorders insofar as determination of the need and justification for the waiver is concerned.

4. RECORDS. For purposes of the formal medical record of individuals authorized a waiver of MPE, appropriate special orders will be issued by CJTF SEVEN upon termination of Task Force activities at the Pacific Proving Grounds. These orders will specify the maximum radiation dosage authorized for each individual concerned.

BY COMMAND OF MAJOR GENERAL CLARKSON:

E. McGINLEY
Brigadier General, U.S. Army
Chief of Staff

OFFICIAL:

Robert Chesney

ROBERT CHESNEY
Major USAF
Adjutant General

1 Incl
Form - Request for Waiver of MPE

DISTRIBUTION "C"

(HEADING)

(DATE)

SUBJECT: Request for Waiver of Maximum Permissible (Radiation) Exposure (MPE)

THRU:

TO: Commander, Joint Task Force SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

1. Request is hereby submitted for waiver of the currently established MPE for Joint Task Force SEVEN on-site activities at the Pacific Proving Grounds. This request for waiver of the MPE is submitted on behalf of, and has the concurrence of, the individual(s) named below. (Omit above statement in the event request for waiver is submitted directly by individual concerned.)

Name	Current Dose	Estimated Dose Increase Required

2. The following information is submitted in justification of this request. (Include pertinent statements in substantiation of the indicated factors.)

a. Technical import of the proposed work.

b. Pre-operational planning for completion of the proposed work within the established MPE.

c. Unforeseen on-site difficulties requiring an increase in MPE to insure completion of the proposed work.

d. Other individual(s) qualified as a substitute.

(Project Officer or equivalent, or Individual)

Incl No. 1

HEADQUARTERS
JOINT TASK FORCE SEVEN
WASHINGTON 25, D.C.

SPECIAL ORDERS
NUMBER 87

4 June 1954

EXTRACT

2. In accordance with paragraph 4, Hq, JTF SEVEN SOP 30-2, 15 Feb 1954 and paragraph 2, Appendix I to Annex N of CJTF SEVEN Operation Order No. 3-53, the Maximum Permissible Exposures (gamma only) for Operation CASTLE of the personnel listed below have been increased by waiver from 3900 milliroentgens (mr) to the values indicated (in mr). This action is in conformance with the intent contained in the authorities listed below and confirms pre-evaluations of the technical import and the medical aspects of specific work conducted on Operation CASTLE which required a departure from occupational safety standards in situations where completion of missions was essential.

.. AUTH: 2nd Ind Office AC of S, G-4, DeptAR file G4/D2-73061, Subject: Radiological Safety Regulations, Operation CASTLE, dated 25 Jan 1954; Ltr CNO, Op-365 B/em, Serial 08?8P36, Subject: Radiological Safety Regulations, Operation CASTLE, dated 13 Nov 1953; 1st Ind DeptAF, Hq USAF, file AFCSG-15, dated 13 Nov 1953; ltr DBM, USAEC, dated 13 Nov 1953.

TASK GROUP 7.1

AUTHORIZED EXPOSURE	AUTHORIZED EXPOSURE
5500	5425
4620	5150
4240	6125
5730	4185
7800	5530
4930	6000
6125	6000
5750	6000
4890	4470
5275	5375
7840	6710
5616	6005
6000	6000
5900	7500
5460	6000
5500	7500
6000	4655
5400	5580
6000	6000
4400	6000
6000	7185
6000	5395
5550	6000
6000	5155
6310	5815
6535	6750
6000	7500
7500	6205
6000	6000

TASK GROUP 7.3
USS MOLALA

AUTHORIZED EXPOSURE	AUTHORIZED EXPOSURE
7800	7800
7800	7800
7800	

YAG 39

11100	10000
6000	10300
5400	4500
4900	6400
6400	7300
5000	4900
9000	11700
6600	9700
7600	8200
9700	4800
4600	9600
4200	4900
5400	9300
7900	6300
8000	9600
8400	8200
4400	6600
4200	5100
7900	6600

YAG 40

6800	7700
7400	5700
10900	5500
4800	4700
4400	8000
6700	7300
8300	5700
7100	7800
7200	8300
9500	5800
6400	4400
6400	7900
6600	8300
8700	8200
6200	7700
6200	8200
4000	5300
7400	8400
6000	6800
7800	7600
6000	7600
6200	7700

TASK GROUP 7.3 (Continued)
USS BAIROKO

AUTHORIZED EXPOSURE	AUTHORIZED EXPOSURE
7800	7800
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USS ESTES

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BOAT POOL

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TASK GROUP 7.3 (Continued)
BOAT POOL

AUTHORIZED EXPOSURE	AUTHORIZED EXPOSURE
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USS PHILIP

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TASK GROUP 7.3 (Continued)
USS PHILIP

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TASK GROUP 7.3 (Continued)
USS PHILIP

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TASK GROUP 7.3 (Continued)
BOAT POOL

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USS BAIROKO

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TASK GROUP 7.3 (Continued)
USS BAIROKO

AUTHORIZED EXPOSURE	AUTHORIZED EXPOSURE
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TASK GROUP 7.3 (Continued)
USS BAIROKO (HMR-362)

AUTHORIZED EXPOSURE	AUTHORIZED EXPOSURE
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TASK GROUP 7.4

7800	7800
7800	7800
7800	7800

TASK GROUP 7.5

6000	6000
6000	6000
6000	6000

BY COMMAND OF MAJOR GENERAL CLARKSON:

OFFICIAL:

Robert Chesney
ROBERT CHESNEY
Major USAF
Adjutant General

E. McGINLEY
Major General, U.S. Army
Chief of Staff

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CORRESPONDENCE AND WIRES RELATIVE TO OFF-SITE RESPONSIBILITIES AND PLANS

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1. Copy ltr from CJTF SEVEN to CINCPACFLT, subj: Rad Hazards in the Marshall Is. Area During Operation CASTLE, dtd 30 Jul 53.
2. Copy ltr from CINCPACFLT to CJTF SEVEN, subj: Rad Hazards in the Marshall Is. Area During Operation CASTLE, dtd 31 Oct 53.
3. Copy ltr from CJTF SEVEN to CINCPAC, subj: Schedule of Msgs Concerning Detonations During CASTLE, dtd 3 Dec 53.
4. Copy ltr from CJTF SEVEN to CINCPAC, subj: Safety Measures During Operational Phase of CASTLE, dtd 11 Dec 53.
5. Copy ltr from CJTF SEVEN to CINCPACFLT, subj: Rad Hazards in the Marshall Is. Area During CASTLE, dtd 11 Dec 53.
6. Copy ltr from CINCPACFLT to CJTF SEVEN, subj: Support of AEC Worldwide Fallout Monitoring Program during Operation CASTLE, dtd 11 Feb 54.
   a. AEC Airborne Monitoring Flight Schedule
7. Msg from CINCPACFLT, DTG 120238Z FEB 54.
8. Msg from CINCPACFLT, DTG 190225Z FEB 54.
9. Msg from CINCPACFLT, DTG 201857Z FEB 54.
10. Msg from CINCPACFLT, DTG 250244Z FEB 54.
11. Msg to CINCPACFLT from CJTF SEVEN, DTG 260010Z FEB 54.
12. Msg from CINCPACFLT, DTG 270033Z FEB 54.
13. Msg to CINCPACFLT from CJTF SEVEN, DTG 280700Z FEB 54.
14. Msg from CINCPACFLT, DTG 190356Z MAR 54.

HEADQUARTERS
JOINT TASK FORCE SEVEN
Washington 25, D. C.

J-3/903 729.3 30 July 1953

SUBJECT: Radiological Hazards in the Marshall Islands Area During Operation CASTLE

TO: Commander in Chief
U. S. Pacific Fleet
c/o Fleet Post Office
San Francisco, California

1. References:

a. Report, "Radioactive Debris from Operation IVY," New York Operations Office, AEC, NYO-4522, dated 28 April 1953.

b. Discussions between Commander Joseph L. Hall, this headquarters and Captain Charles B. Martell during February 1953.

2. Reference 1a presents basic information relative to the radiological hazards introduced into the Pacific Area as a result of Operation IVY. Reference 1b involved a discussion on behalf of the cognizant technical section of this headquarters relative to the desirability and need on Operation CASTLE for atomic cloud tracking outside the immediate danger area, sampling of drinking water on distant atolls and evacuation of native populations.

3. As a result of the discussions indicated in reference 1b and relying on the substantial radiological documentation of reference 1a, this headquarters does not plan to mount special efforts in support of the above listed safety measures during Operation CASTLE. It appears that it would be unrealistic to assume health hazards of a magnitude conjectured or anticipated during the planning for Operation IVY. In addition, economy of forces and equipment, especially in view of the recent reductions in fiscal year 1954 service budgets, dictate a policy of austerity in all phases of the operation. As a consequence, all CASTLE Operations have been reduced except where positive evidence indicates a reasonable need for a major effort.

4. Although the items in question are not programmed as special operations during CASTLE, certain other aspects of the radiological safety plan do provide a reasonable and safe compromise. Specifically, these are as follows:

a. Reference cloud tracking, an effort will be made to

determine information relative to the forecasting of heavy secondary fall-out on the shot site. This will be accomplished by a small number of WB-29 flights up-wind from the shot site to a distance of approximately 600 miles. Since the up-wind direction will, in general, be toward the populated atolls, minor modifications in aircraft tracks should provide sufficient information on conditions in those areas. Also, certain specified aircraft operating in the area of the tests after shot time will be in positions to provide reasonable indications of actual cloud movements. In addition, as on Operation IVY, the Task Force Commander will issue pre-shot forecasts of cloud trajectories and fall-out areas and will continue such advisories with post-shot analyses of the sources of information available.

b. Reference drinking water sampling at distant atolls, existing equipment could, on a limited basis, be diverted to such a post-shot effort in the event cogent and compelling reasons arose requiring such action. Past experience indicates, however, that such action is necessary only under extreme conditions.

c. Reference evacuation of native populations, no task force equipment will be available for such an operation. Consideration of populated islands will, however, be one of the major factors in the Commander's decision to shoot, and will be considered in its relation to forecast winds and fall-out predictions.

5. This command is constantly faced with compromise between the necessity for certain efforts and the limitations of forces and equipment available to accomplish objectives. Your comments or suggestions in consonance with the above are requested in order that task force planning may be realistic and mutually agreeable to all concerned.

FOR THE COMMANDER:

s/Robert H. Cushing
t/ROBERT H. CUSHING
Colonel USA
Actg Chief of Staff

UNITED STATES PACIFIC FLEET
Headquarters of the Commander in Chief

In reply refer to:
CINCPAC File
FF1-1
A4-3
Ser 001355

31 Oct 1953

From: Commander in Chief, U.S. Pacific Fleet
To: Commander, Joint Task Force SEVEN

Subj: Radiological Hazards in the Marshall Islands Area During Operation CASTLE

Ref: (a) CJTF Secret ltr J-3/903 X 729.3 of 30 Jul 1953
(b) US AEC New York Operations Office Report NYO-4522 on "Radioactive Debris from Operation IVY" of 28 Apr 1953
(c) CINCPAC Secret ltr FF1-1 A16-1 Ser 0035 of 22 Apr 1952
(d) CJTF 132 Secret ltr of 14 Jul 1952; Subj: "Safety Measures during Operational Phase of IVY.
(e) CINCPAC Secret ltr FF1-1 A4-3 Ser 0073 of 25 Aug 1952

1. Reference (a) sets forth preliminary planning of CJTF 7 regarding radiological safety measures proposed for Operation CASTLE in relation to those implemented for Operation IVY, and requests CINCPACFLT comments or suggestions in order that task force planning may be realistic and mutually agreeable to all concerned. For convenient reference, the task force plan is summarized in paragraph 2 below.

2. CASTLE Radiological Safety Plan Proposed by CJTF 7.

a. No special efforts will be implemented by JTF 7 in support of the following safety measures:

(1) Atomic cloud tracking outside the immediate danger area.

(2) Sampling of drinking water on distant atolls.

(3) Evacuation of native populations.

b. The conclusion to discontinue the above safety measures (established for Operation IVY) is based on the following factors:

(1) Discussions between cognizant sections of both headquarters during February 1953.

(2) Reliance on the substantial radiological documentation obtained for IVY in reference (b).

(3) Apparent unrealism in the assumption of health hazards of a magnitude conjectured for IVY.

Incl 2 to TAB "C"

(4) Policy of austerity in all phases of the operation dictated by re... t reductions in fiscal year 1954 service budgets.

c. Specific aspects of the proposed plan, which are considered to provide a reasonable and safe compromise are as follows:

(1) Cloud tracking will comprise:

(a) WB-29 flights upwind from the shot site out to approximately 600 miles for the purpose of forecasting heavy secondary fall-out on the shot site with deviations in aircraft tracks to provide information on conditions in populated atolls near the upwind sector.

(b) Use of specified aircraft operating in the test area after shot time to provide reasonable indications of actual cloud movements.

(c) Pre-shot forecasts of cloud trajectories and fall-out areas with the continuation of such advisories by post-shot analyses of information from available sources (same procedure used for IVY).

(2) Sampling of drinking water at distant atolls will be conducted as a post-shot effort only in the event of radiological conditions requiring such action.

(3) Evacuation of native populations is not planned for JTF 7 effort due to unavailability of task force equipment. However, consideration of populated islands will be one of the major factors influencing the decision to shoot.

3. Since IVY provides the sole criterion for the present determination of adequate safety precautions for the Pacific area incident to thermonuclear tests, it is considered appropriate to review the measures implemented for that operation. For this purpose, the basic directives, advisories and precautions pertinent to IVY safety are briefly outlined in paragraphs 4 through 6 below.

4. Basic Directives for Safety During IVY.

a. Reference (e). In consonance with the JCS decision relative to responsibilities during future tests at the Pacific Proving Ground, CINCP. directed CJTF 132 to:

(1) Advise CINCPAC at an appropriate time of special hazards involved in the tests and appropriate precautions required to insure safety

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of inhabited islands and of surface and air units of the Pacific other than those of JTF 132.

(2) Take all possible measures to minimize hazards to inhabitants of populated islands of the Pacific.

b. Reference (e). CINCPAC directed CINCPACFLT to:

(1) Assume complete responsibility for CINCPAC and take such action as necessary to provide for the safety of all units and populated areas of the Pacific, except those attached to JTF 132, incident to the hazards introduced by IVY.

(2) Keep CINCPAC and CNO informed of the provisions for safety to be taken in the Pacific.

5. <u>Basic Safety Advisory for IVY</u>.

a. Reference (d). In compliance with reference (c), CJTF 132 advised CINCPAC as follows:

(1) With respect to the probability of health hazards, it is concluded that:

(a) The existence of such a hazard at Ujelang is a possibility and therefore it is recommended that CINCPAC provide a capability for the temporary evacuation of the native inhabitants.

(b) Air routes through Wake may be affected for short periods of time.

(2) Using weather as a major safety measure, MIKE shot would be detonated at a time when wind conditions present minimal health hazards to inhabited islands, air and surface traffic routes of the Pacific.

(3) Further information relative to radiological hazards would be dispatched to CINCPAC in advisory messages as follows:

(a) At M minus 9 hours - a summary giving the prognosis of the atomic cloud trajectory for the initial 7[illegible]-hour period, including best estimates of hazards to air and surface routes and the radsafe outlook for Ujelang.

(b) M to M plus 8 days - a daily summary (2000 local time) of radsafe information based on:

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1. Cloud tracking to 1000 miles in the significant quadrant, probably northeast from zero point.

2. Monitoring of water samples from certain inhabited atolls to a radius of approximately 600 miles.

3. Radiological reports from fixed weather stations.

6. Safety Measures in the Pacific Area During IVY.

a. In order to provide for the safety of areas and units other than those assigned to JTF 132, CINCPACFLT implemented the following measures for IVY:

(1) Temporary evacuation of Ujelang by a PACFLT vessel.

(2) Airborne surveys of the Hawaiian, Marshalls, Carolines and Marianas Islands supplemented by ground checks as practicable as outlined in reference (b).

(3) Film badge survey of Wake and Johnston Islands.

(4) Reconnaissance flights (by security aircraft in TG 132.3) to clear itinerant shipping from the predicted cloud passage area out to 800 miles on M minus 2 and M minus 1 days.

(5) Informed the CAA Ninth Region administrator about the possibility of interference with air routes through Wake for short periods of time (a probability concluded by CJTF 132) and made arrangements for closing or modifying these routes on short notice in the event such actio became essential.

(6) On the basis of radsafe advisories from CJTF 132, the Kwajalein-Guam air route was closed from H to H plus 24 hours for MIKE shot only.

(7) For operational reasons as requested by CJTF 132, both Kwajalein and Eniwetok Air Bases were closed for short periods before and after such detonation.

7. Comments on CASTLE Radiological Safety Plan Proposed by CJTF 7 (paragraph 2 above.

a. With respect to atomic cloud tracking outside the immediate

danger area, the proposal to mount no special effort in this behalf is viewed with concern for the following reasons:

(1) On the basis of IVY reports received to date, no criterion exists for assuming that significant fall-out hazards from atomic cloud concentrations will arbitrarily limit such possibilities to within the confines of the relatively small danger area now established.

(2) During IVY, almost every atoll and island in the Trust Territory was surveyed by airborne monitoring as described in reference (b) even though negative or insignificant residual radiation was anticipated for the most part. For CASTLE, it is planned to provide the same capabilities established for IVY, but actual monitoring flights will be implemented only in regions where a probability of fall-out is believed to exist. Since the movement of significant radioactive clouds is a major factor in the definition of precise areas where fall-out may possibly occur, it is evident that actual cloud tracking is essential to determine appropriate monitoring flights subsequent to each CASTLE shot. Although it is realized that similar information can be obtained to some degree by cloud trajectory predictions based on meteorological observations and continuous monitoring at fixed stations, such prognostic reports and those limited to predetermined locations will not establish all possible fall-out regions in the Trust Territory. Consequently, it would be necessary to repeat the extensive aerial surveys flown during IVY if cloud tracking beyond the immediate danger area by task force aircraft is discontinued.

(3) During prognostication of special hazards incident to IVY, interference with air routes through Wake was concluded to be a possibility. Although no interference actually resulted from that singular instance, CINCPACFLT has no factual data which would eliminate the possibility of this potential hazard during CASTLE. Therefore, it is considered that cloud tracking is the only positive means of guarding against this hazard with a view toward punctual initiation of appropriate safety measures in the event of its materialization.

(4) CINCPACFLT does not concur with the consideration that the plan proposed in subparagraph 2c(1) above provides a reasonable and safe compromise for the following reasons:

(a) In view of the fact that WB-29 flights will be conducted upwind from the shot site and are for the purpose of forecasting fall-out on the shot site, it is not apparent that this measure will aid in determining conditions in the significant downwind sector (predicted cloud passage area). Conditions in the populated atolls near the upwind sector

present least concern since they are situated in a potentially safe region.

(b) Eniwetok and Bikini (shot sites) are the only populated atolls inside the danger area. Units assigned JTF 7 will be the only forces operating inside the danger area. Since the safety of JTF 7 and the shot sites is the responsibility of CJTF 7, cloud tracking within the danger area will not provide information useful to CINCPACFLT in the discharge of his responsibilities for the safety of other units and populated islands of the Pacific.

b. CINCPACFLT concurs in the plan to sample drinking water only if required by radiological conditions (proposal in subparagraph 2c(2) above A sampling program of the degree mounted for IVY is not considered necessary for CASTLE.

c. In the formulation of radsafe measures for CASTLE, every effort should be made to eliminate the necessity for evacuation of native populations. The temporary evacuation of Ujelang by a PACFLT vessel during IVY was implemented by CINCPACFLT upon the advice of CJTF 132. In reference (d), CJTF 132 concluded that the existence of a health hazard at Ujelang was a possibility and recommended provision of an evacuation capability. During a preliminary survey of Ujelang to study the situation and make plans, the capability for evacuating natives on short notice was concluded to be impracticable, and a planned orderly evacuation was considered to be the only logical solution. The decision to evacuate Ujelang was predicated not only on reducing health hazards to the indigenes to an acceptable minimum, but also to protect them from possible radiation hazards beyond the shadow of any adverse reflections on the U. S. Government. From the proposals and conclusions in the CASTLE RadSafe Plan (subparagraphs 2a(3), 2b(2), and 2c(3) above, it is apparent that IVY technical and operational experience indicates realistic planning may be based on the premise that no significant health hazards will exist in Ujelang or other populated atolls. Accordingly, it is considered that planning in this respect should include the following basic premises:

(1) The decision to shoot should be reached with the understanding that no health hazard to units and populated islands of the Pacific or radsafe conditions conducive to possible adverse criticism will ensue.

(2) CJTF 7 advisories on appropriate safety precautions incident to CASTLE will not contain conclusions requiring evacuation of populated islands.

(3) In the remote circumstance that extreme post-shot conditions develop a necessity for the temporary evacuation of any populated island

in the Marshalls, units of JTF 7 would be required to accomplish this emergency measure upon the request of CINCPACFLT.

d. Advisories issued by CJTF 132 during IVY (paragraph 5 above) were entirely satisfactory and are similarly desired for CASTLE subject to the deletion of unrealistic measures by mutual agreement. Although health hazards of the magnitude surmised for IVY appear unwarranted on the basis of that singular experience, it is considered that any downward revision of the safety measures implemented for IVY should be justified with reference to scientific findings tending to support this current radsafe concept. To determine adequate CASTLE precautions, CINCPACFLT desires recommendations from CJTF 7 which include a full evaluation of measures instituted for IVY as set forth in paragraph 6 above. In such analysis, it should be borne in mind that CINCPACFLT has previously agreed to conduct airborne monitoring (subparagraph 6a(2) above) in cooperation with the Atomic Energy Commission.

e. Reference (c) and (e) as briefly outlined in paragraph 4 above constitute basic CINCPAC directives issued for Operation IVY. It is contemplated that the basic policies in these references will be retained for CASTLE and reissued as new directives prior to the operations.

f. Prior to IVY, CINCPACFLT requested information on the long range detection program sponsored by the U. S. Air Force Office of Atomic Tests (HQ USAF WASHDC (AFOAT-1) which could be used to advantage in the radiological safety program during the operation. This request further provided for AFOAT-1 to furnish any information that might be obtained on the locations of the clouds from the IVY explosions and the calculated intensity in these various Pacific flights made by aircraft equipped with air filter devices. In general, the intensities recorded were insignificant and these flights reflected no pattern of correlation with the actual atomic cloud tracks. In view of the AFOAT-1 cooperation received for IVY, it is suggested that AFOAT-1 be requested to supplement JTF 7 tracking in order to provide information of a degree essential to CINCPACFLT for the discharge of his responsibilities incident to Pacific safety.

g. Under the proposed radsafe plan, the daily information summaries for the post-shot week (subparagraph 5a(3)(b) above) would be based only on radiological reports from fixed weather stations. Considering the minute number of such stations in relation to the vast expanse of the Pacific area, these reports will not be nearly as reliable as those during IVY and will have no value in areas beyond the vicinity of the weather stations.

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h. It is understood that recent developments indicate that only a very small portion of the radioactive energy generated by the MIKE detonation has been recorded in the process of continuous fall-out monitoring extrapolated to the present date. As a result, two possible conclusions have been formed. First, residual radioactivity is still scattered above the tropopause. Second, major fall-outs have occurred on the open sea which have gone undetected. To gain more knowledge of the second factor, the AEC proposes to place gummed paper collectors on various naval controlled ships transiting the Pacific during Operation CASTLE. In view of this development, it is considered unwise to place too strong a reliance on the substantial radiological documentation obtained in reference (b).

8. Reproduction and numbered distribution in local series are authorized when total additional distribution list is furnished the issuing office.

s/H. G. Hopwood
t/H. G. HOPWOOD
Chief of Staff

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HEADQUARTERS
JOINT TASK FORCE SEVEN
Washington 25, D. C.

J-3/300.4

3 December 1953

SUBJECT: Schedule of Messages Concerning Detonations During CASTLE

TO: Commander in Chief, Pacific
Navy No. 128, c/o Fleet Post Office
San Francisco, California

1. In order that you may be kept informed of developments during the operational phase of CASTLE, operational priority messages will be sent to your headquarters prior to and subsequent to the detonation of each of the weapons and devices in accordance with the following schedule:

a. D-Day minus 5 days:

(1) Anticipated time of detonation (GCT).

(2) Information relative to closing of Eniwetok and Bikini air bases.

b. H-Hour minus 18 hours:

(1) Forecast atomic cloud trajectory for the initial 72 hour period after detonation.

(2) Radiological outlook for native populated atolls.

(3) Anticipated radiological impact on air and surface routes, including recommendations relative to closing routes.

c. H-Hour plus 30 minutes:

(1) Exact time (GCT) of detonation.

(2) Safety of personnel.

d. Daily at 2000 hours local starting on D-Day and continuing until significant information ceases.

(1) Verification or revision of atomic cloud trajectory.

(2) Verification or revision of radiological outlook for native populated atolls.

(3) Verification or revision of radiolcgical impact on air and surface routes including recommendations relative to opening air and surface routes.

2. In addition to these scheduled messages, you will be informed as quickly as possible of any unexpected and significant developments. If this plan of notification does not appear adequate, it is requested that you indicate your desires to this headquarters.

s/P. W. Clarkson
t/P. W. CLARKSON
Major General, U.S. Army
Commander

HEADQUARTERS
JOINT TASK FORCE SEVEN
Washington 25, D. C.

J-3/729.3 11 December 1953

SUBJECT: Safety Measures During Operational Phase of CASTLE

TO: Commander in Chief, Pacific
c/o Fleet Post Office
San Francisco, California

1. References:

a. CJTF 132 Secret letter, subject: "Safety Measures During Operational Phase of IVY", dated 14 July 1952.

b. CJTF SEVEN Secret letter, subject: "Schedule of Messages Concerning Detonations During CASTLE", dated 3 December 1953.

2. It is anticipated that the shot hazards introduced into the Pacific Area during Operation CASTLE will, with one exception, closely parallel those encountered on the IVY-MIKE shot. The exception is expected to occur, due to reduced yield, on the ECHO shot at Eniwetok Atoll. Accordingly, the general information presented in above reference on IVY safety measures, and restated below with pertinent modifications, is considered applicable to Operation CASTLE.

a. With respect to the probability of fall-out hazards, it is concluded that the existence of such at UJELANG is a remote possibility. Similar hazards at other islands in the vicinity of shot sites are considered very remote. The impact of fall-out on populated islands will be one of the major factors in the task force commander's decision to shoot, and will be considered in its relation to forecast winds and other meteorological conditions. In the event that cogent and compelling post-shot reasons arise requiring temporary evacuation of natives, task force security ships will be made available to CINCPAC for this purpose. Personnel with Trust Territory administration and interpretation experience would be required from your command to supervise this effort.

b. Although various uncertainties exist in predetermining the trajectory of an atomic cloud with resultant radioactive fall-out, all possible measures to minimize health hazards will be taken by this command. CJTF SEVEN will use weather as a major safety measure, detonating the shots at a time when wind conditions present minimal hazards

to inhabited islands and air and surface routes of the Pacific. During the pre-shot and post-shot phases, CJTF SEVEN will advise CINCPAC of any unforeseen hazards, which may develop during the operations, and will recommend appropriate precautions by dispatch of advisory messages as indicated in reference 1b.

c. Air and surface routes through Wake and the Marshall Islands may be effected for short periods of time. Pertinent information supporting action relative to closing and opening such routes will be included in advisories to your headquarters (reference 1b).

d. Reconnaissance flights by security aircraft of TG 7.3 to clear itinerant shipping from the predicted cloud passage area up to 600 miles on shot minus 1 to 2 days will be conducted in the significant fallout quadrant.

3. In the interest of minimizing hazards in areas and units other than those assigned to JTF SEVEN, it is recommended that the following measures, similar to those implemented by CINCPACFLT for Operation IVY, again be taken with facilities at your disposal:

a. Airborne survey of significant Pacific Islands, supplemented by ground checks as practicable, in cooperation with the Atomic Energy Commission.

b. Film badge survey of Wake and Johnston Islands (extended to include significant native populated atolls).

c. Advance coordination with the CAA Administrator on possible interference with air routes through Wake and the Marshall Islands for specified periods of time, and arrangements for closing or modifying these routes on short notice in the event such action becomes essential. It is also anticipated that, for operational reasons, both Eniwetok and Bikini air bases will be closed for short periods before and after each detonation. Appropriate advisories to your headquarters will include information supporting these actions.

d. Advance coordination for Headquarters, USAF (AFOAT-1) support of cloud tracking by supplying radiological data from various Pacifi flights. By separate communication this support has been requested for CINCPACFLT.

4. CINCPACFLT will be informed by separate communication of details pertinent to the above information.

s/P. W. Clarkson
t/P. W. CLARKSON
Major General, U.S. Army
Commander

c / 4

HEADQUARTERS
JOINT TASK FORCE SEVEN
Washington 25, D. C.

J-3/729.3

11 December 1953

SUBJECT: Radiological Hazards in the Marshall Islands Area During CASTLE

TO: Commander in Chief, U.S. Pacific Fleet
c/o Fleet Post Office
San Francisco, California

1. References:

a. CINCPACFLT SECRET letter, subject as above, dated 31 October 1953.

b. CJTF SEVEN SECRET letter to CINCPAC, subject: "Schedule of Messages Concerning Detonation During CASTLE," dated 3 December 1953.

c. CJTF SEVEN SECRET letter to CINCPAC, subject: "Safety Measures During Operational Phase of CASTLE," dated 11 December 1953.

2. Information presented in your letter has been considered in the revised CASTLE radsafe plan (reference 1c). Comments on critical paragraphs and details on primary matters of interest are presented below for your information.

3. Reference paragraph 2 of your letter.

a. In consideration of your responsibilities and because of other task force developments since July 1953, the cloud tracking effort on Operation CASTLE has been augmented. It is considered that the areas of most concern, in sequence of priority interest, are as follows:

(1) The down-wind (trade wind) region from Ground Zero (GZ). This area would include both the task force camp at Eniwetok and the native populated atoll of Ujelang.

(2) The up-wind (trade wind) region from GZ. This is the region from which secondary fallout could occur on the task force camp site.

(3) The up-wind (trade wind) region from the native populated atolls in the southeast quadrant. This area is of concern for the same reason as 3a(2) above, but considered of less priority due to its more favorable location with respect to GZ.

Incl 5 to TAB "C"

(4) Air and surface routes through Wake and the Marshall Islands. These areas are considered of least priority because of separate advance plans to close or sweep the most questionable areas.

b. Cloud tracking has been planned accordingly as follows:

(1) In support of 3a(1) above, starting at H Hour, one aircraft will maintain a holding pattern for approximately 5 hours downwind from GZ to establish the drift of contamination toward Eniwetok and/or Ujelang. In addition, the cloud sampling team will report on drift and intensity of all segments of the cloud from H to H plus 6 hours. Further, it is planned that all operational and test aircraft will report any encounter with radiation while engaged in their assigned flight missions. The totality of information above, together with the forecast trajectories, should be sufficient to present a reasonably clear indication of future developments of the cloud, and in sufficient time to verify decisions relative to safety of personnel outside the shot area. This information will also be used to formulate a decision relative to the air and surface routes through the Marshalls.

(2) In support of 3a(2) above, from approximately H plus 5 hours to H plus 12 hours, one aircraft will search up-wind in a 30 degree sector, apex on GZ, and centered on the average trade-wind for approximately 500 NM.

(3) In support of 3a(3) above, from approximately H plus 12 hours to H plus 18 hours, one aircraft will search up-wind in a 30 degree sector as above, with apex on Rongerik Atoll.

(4) In support of 3a(4) above, from approximately H plus 18 hours to H plus 24 hours, one aircraft will be vectored along the routes through Wake, or through the area forecast to be up-wind from these routes, as appropriate.

(5) Two additional aircraft are planned to search from H plus 24 hours to H plus 36 hours, and from H plus 36 hours to H plus 48 hours. The flight tracks of these aircraft will be determined after the shot and will be based upon the results of the first 24-hour period and forecast meteorological conditions.

c. Other features of the task force plan remain unchanged except that appropriate comments relative to native evacuation are presented below as they apply to pertinent paragraphs of your letter.

4. Reference paragraph 4, your letter, action has been taken to inform CINCPAC by reference 1c of the hazards to be introduced into the Pacific Area during CASTLE.

5. Reference paragraph 5, your letter, similar advisories (reference 1b) are planned again for Operation CASTLE. Particular attention is invited to the H minus 18 hour message. Due to shot times in the early morning hours, and the necessity for final shot decision briefings to take place after all daylight weather information has been collected and analyzed, it is considered that a tentative H minus 18 hour planning forecast is necessary. In the event the H minus 18 hour forecast is significantly in error, a modification advisory will be dispatched after the commander's final shot decision briefing at about H minus 6 hours.

6. Reference paragraph 6, your letter, the following comments and recommendations are made:

a. Temporary evacuation of native populated islands is not recommended as a pre-shot measure.

b. Airborne survey of the Hawaiian, Marshall, Caroline and Marianas Islands, supplemented by ground checks as practicable, in cooperation with the Atomic Energy Commission is considered a valuable adjunct to the radsafe plan. Overlap of information in support of this effort will be furnished by CJTF SEVEN to the AEC representative in the Forward Area such that actual survey flights will be necessary only in the event fall-out is forecast or known to exist in the area in question. It is considered that such coverage is practicable and will be extremely useful to all commands and agencies concerned with cloud trajectory analysis in the Pacific Area.

c. Film badge survey of Wake and Johnston Islands. This type survey is considered desirable if for no other reason than to provide positive evidence that no contamination was encountered. Since the film badge is considered the only legally acceptable record of radiation exposure, it is suggested that such a survey should be extended to significant native populated atolls. If desired, task force film badge supply and processing facilities can be made available to assist.

d. Reconnaissance flights by security aircraft of TG 7.3 to clear itinerant shipping from the predicted cloud passage area up to 600 miles on shot minus 1 to 2 days are considered a valuable radiological safety precaution. Such flights are planned again for CASTLE. It is suggested that, in the interest of reducing the number of ships to be cleared from the area, CINCPACFLT effect appropriate advance diversions of surface shipping wherever practicable. As a first approximation, it is considered that the sector area centered on ground zero clockwise from 225° true to 90° true, maximum distance 500 nm, should be avoided on shot day. Task force advisories may be used by CINCPAC to inform operational control authorities of further routing modifications as required.

e. It is anticipated that recommendations will again be made by this headquarters reference closing of air routes. Consequently, the CAA Administrator should be informed of possible interference with air

routes through Wake and the Marshall Islands for specified periods of time and that arrangements should be made for closing or modifying these routes on short notice in the event such action becomes essential. It is also anticipated that, for operational reasons, both Eniwetok and Bikini air bases will be closed for short periods before and after each detonation. Appropriate advisories to CINCPAC will include information supporting such action.

7. Reference paragraph 7, your letter, the comments below refer to the numbered paragraphs of your letter:

a. Reference paragraph 7a(1), information from atomic shots in Nevada indicate that clouds which reach the tropopause drop out a unique and major portion of the fall-out at a distance on the order of 100 miles or less from GZ. On the assumption (as on IVY) that the tropopause acts as a trapping barrier for all contamination at or above this level, it is expected that high yield shots should similarly react, extending perhaps to a slightly greater horizontal distance due to the fact that the Pacific tropopause height is higher by approximately 15,000 feet. On the assumption that the trapping action of the tropopause is not so complete as to prevent a gradual sifting of material from above it, the wide and distant area coverage by NYOO of AEC is considered essential. The weak point of the first argument lies in the fact that, due to operational difficulties, none of the high yield shots in the Pacific have been sufficiently documented in this respect. Consequently, our operational planning anticipates a remote possibility of adverse conditions out to populated atolls.

b. Reference paragraph 7a(2), it is suggested that the augmented cloud tracking effort outlined above should alleviate the difficulties presented.

c. Reference paragraph 7c(1), the decisions to shoot will be reached with the understanding that no health hazards to units and populated islands of the Pacific are forecast. It is not believed the decision can be reached with the understanding that no radsafe conditions conducive to possible adverse criticism will ensue. The differentiation made here is due to limitations on weather and radsafe forecasting techniques and due to the many and diverse interpretations of radsafe conditions which are adverse.

d. Reference paragraph 7c(2), CJTF SEVEN pre-shot advisories, (based on forecasts) will not contain conclusions requiring evacuation of populated islands to avoid a health hazard. Information will necessarily be included relative to the probabilities of something less than a health hazard occurring.

e. Reference paragraph 7c(3), Eniwetok and Ujelang are considered the most critical sites, and since contamination of these sites will likely be a collateral occurrence, all task force ships will

probably be engaged in danger area evacuation efforts. In the event cogent and compelling post-shot reasons arise requiring temporary evacuation of any populated island in the Marshalls outside the danger area, the task force security ships would have to be used.

f. Reference paragraph 7d, an evaluation of CINCPACFLT IVY measures is included in paragraph 6 above.

g. Reference paragraph 7f, action has been taken to request Headquarters, USAF (AFOAT-1) to furnish the desired information on CASTLE. This request contained a recommendation for direct contact between your headquarters and AFOAT-1 to arrange the details.

h. Reference paragraph 7g, augmentation of the cloud tracking effort should alleviate the difficulty presented.

i. Paragraph 7h, noted in its relation to paragraph 7a above.

s/P. W. Clarkson
t/P. W. CLARKSON

UNITED STATES PACIFIC FLEET
HEADQUARTERS OF THE COMMANDER IN CHIEF

IN REPLY REFER TO
CINCPACFLT FILE
FF1-1
A11
Ser 00113
11 February 1954

From: Commander in Chief U.S. Pacific Fleet
To: Commander Joint Task Force SEVEN
Commander Naval Forces, Marianas
Commander Fleet Air Hawaii
Commanding Officer, Naval Station Kwajalein

Subj: Support of Atomic Energy Commission Worldwide Fallout Monitoring Program during Operation CASTLE

Ref: (a) CINCPACFLT Secret msg 190221Z of Jan 1954
(b) CINCPACFLT Secret ltr FF1-1 A4-3 Ser 00849 of 3 Oct 1952
(c) CINCPACFLT Secret msg 240008Z of Sep 1952
(d) US AEC NYKOPO Secret ltr HS:ME of 8 Sep 1953
(e) CJTF 7 Secret ltr J-3/903 undated
(f) CINCPACFLT Secret ltr FF1-1 A8-6 Ser 001210 of 28 Sep 1953
(g) CINCPACFLT Secret msg 302221Z of Jan 1954
(h) CINCPACFLT Secret msg 220431Z of Jan 1954
(i) COMAIRPAC msg 222020Z of Jan 1954
(j) CINCPACFLT Secret ltr FF1-1 A11 Ser 0073 of 28 Jan 1954

1. Reference (a) advised cognizant commanders that Pacific Fleet support of the subject program will be generally similar to that previously rendered during Operation IVY as outlined in references (b) and (c), except for a reduction in the airborne monitoring effort. It further directed COMHAWSEAFRON to assist AEC Project Officers in preparatory missions pertinent to the Hawaiian Area.

2. Purpose. This letter summarizes the details of the program and outlines the support required from cognizant commanders. It further confirms earlier planning and agreements.

3. Background.

a. This program is a continuing project supported by the U. S. Weather Bureau and other government agencies. As in IVY, more definitive coverage in the Pacific during CASTLE tests serves the dual purpose of extending AEC knowledge of worldwide fallout patterns and assisting CINCPACFLT (as agent for CINCPAC) in discharging his responsibility for safety in the Pacific Area.

b. The airborne and ground monitoring techniques previously described in reference (b) have not basically changed since IVY. Since the AEC New York Operations Office has developed Standard Operating Procedures (SOPs) for the use of participating activities, descriptions of monitoring techniques are omitted in this letter.

4. General Plan.

a. Aerial monitoring of the Pacific Area will be again conducted by aircraft operating from Kwajalein, Guam and Oahu. Support of the mission at Kwajalein and Guam will be provided by patrol aircraft from VP-29, and at Oahu by aircraft from VW-1.

b. Basic flight patterns adapted for IVY (reference (b)) are unchanged and have been reproduced by the AEC in the SOPs mentioned in paragraph 3. above. Deviations from these patterns are authorized if desired by the AEC Project Officer.

c. AEC representatives for this program have been assigned to temporary duty with Joint Task Force SEVEN in the Eniwetok/Bikini Area. As indicated in reference (a), these representatives are:

(1) Mr. A. J. Breslin — Project Officer

(2) Mr. M. E. Cassidy — Assistant Project Officer

d. During aerial monitoring operations, radiation measurements will be made by aircraft crews rather than by AEC representatives. This change is justified by the relative ease of measurements demonstrated during IVY, and further simplification of this equipment for CASTLE. These aerial scintillation instruments (SCINTAMETER) are being assigned to participating squadrons by the AEC Project Officers who are instructing squadron personnel regarding their use.

e. Monitoring flights will be requested subsequent to each CASTLE detonation by the Project Officer on the basis of post shot developments. After each detonation, certain survey flights may be eliminated if data from ground installations confirm meteorological predictions that fallout in a given area is unlikely.

f. Ground monitors are being installed at Truk, Yap, Ponape, Kusaie, Majuro, Rongerik, Ujelang, Wake and Midway. At these stations, automatic recorders will continuously monitor gamma radiation and count any concentration of airborne radioactive dust. Arrangements have been made for the attendance of this equipment by Weather Service or Task Force personnel as appropriate. The exception to this arrangement is Midway where it is desired that naval station personnel supervise the installation. In addition to the above network, the U. S. Air Force (AFOAT-1) has been requested to augment gamma monitoring by reporting from stations at Oahu, Guam, Luzon, Tokyo, and possibly Okinawa, Shemya and Anchorage.

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g. In the event of special circumstances such as extensive fallout in a single area or equipment failures, AEC Project Officers may desire high priority air transportation to that location. Such requests should be approved when feasible.

h. Mr. Breslin, as Project Officer, will keep CINCPACFLT informed regarding the progress of the program through normal service communication channels. Reports from ground monitoring stations and squadrons making airborne surveys will be transmitted to the Project Officer for evaluation. Message reports from the Project Officer to CINCPACFLT should include the following type of information:

(1) Proposed schedule of requesite airborne monitoring flights subsequent to each shot.

(2) Completion of airborne monitoring flights including a brief description of radiological conditions. Under normal circumstances where readings are generally insignificant, this report should indicate the highest reading (mr/hr) noted and a statement that no significant radsafe conditions were encountered.

(3) Unusual conditions, if any, recorded at ground monitoring stations.

(4) Any special circumstances of interest to the safety mission in the Pacific Area.

5. Program Details for Kwajalein.

a. References (d) and (e) pertain to completed arrangements between the AEC and CJTF 7 concerning JTF 7 support of the subject program. Reference (f) advised CJTF 7 that:

(1) For CASTLE, it is planned to provide the aircraft capability for airborne fallout monitoring both at Guam and Kwajalein for short intervals after each shot, utilizing security aircraft (VP) as in IVY.

(2) For airborne survey in any area of the Trust Territory, it is planned to utilize 1 to 3 patrol aircraft (VP-29) operating from Guam and/or Kwajalein as needed to fulfill this mission.

b. It is requested that Commander Joint Task Force SEVEN:

(1) Support the program outlined for Kwajalein with task force aircraft and facilities in accordance with previous arrangements mentioned in subparagraph 5.a. above.

(2) Release requisite security aircraft (VP-29) after each shot from Task Group 7.3 to the temporary operational control of COMNAVMARIANAS for post shot airborne surveys in the Marianas and Western Caroline Islands (if required).

(3) Conduct post-shot airborne surveys of the Marshall and Eastern Caroline Islands with VP-29 aircraft as requested by the AEC Project Officer.

(4) Transmit requisite information from the AEC Project Officer to CINCPACFLT.

c. It is desired that the Commanding Officer, Naval Station Kwajalein provide PBM flights as practicable to outlying ground monitoring installations in the Marshall Islands. Since the installation at Ujelang will be battery operated and unattended, it is expected that at least one flight to this site will be required after each shot. The remaining installations in the Marshall Islands are located at Task Force Weather Islands and are attended by Task Force personnel. Therefore, flights to these sites may be combined with normal PBM trips scheduled for resupply of weather stations.

6. <u>Program Details for Guam</u>: It is desired that Commander Naval Forces, Marianas support the subject program for Guam in a manner similar to that rendered during IVY. Specific requirements for CASTLE are:

a. The conduct of post-shot airborne surveys of the Marianas and Western Caroline Islands with VP-29 aircraft (from Task Group 7.3) as requested by the AEC Project Officer.

b. Possible air transportation for the AEC Assistant Project Officer to Truk and Yap for repair or maintenance of equipment at these ground monitoring stations. Reference (g) provided for preparatory requirements at these sites.

c. The possibility that survey flights may be desirable in areas beyond the cognizance of COMNAVMARIANAS. If this eventuality materializes, the Project Officer will request aerial surveys in the Phillippines and/or Japan. If so, it is desired that COMNAVMARIANAS implement these surveys, with VP-29 aircraft if feasible, and make requesite arrangements with cognizant commanders of the areas involved.

7. <u>Program Details for Oahu</u>.

a. References (h) and (i) provided the capability for airborne monitoring in the Hawaiian/Midway Area using aircraft from Squadron

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VW-1 which fulfilled the IVY mission. Requisite instruments and instructions for squadron personnel were provided by the AEC Project Officer during his recent preparatory visit.

b. It is desired that Commander Fleet Air Hawaii support the program for Oahu using VW-1 aircraft as outlined in reference (h). Aerial surveys, if required, should be implemented upon direct request from the AEC Project Officer.

8. Reference (j) pertains to features of the subject program which are useful only for documentation purposes. Since the results of this feature are available only after laboratory analysis, it serves no use for immediate evaluation of local radiological conditions.

H. G. HOPWOOD
Chief of Staff

Copy to:
CNO (Op 36)
CINCPAC
AEC WASHDC (DMA)
AEC NYKOPO (2 copies)
CJTF 7 (for AEC Project Officer)
CTG 7.3
COMNAVPHIL
COMNAVFE
COMHAWSEAFRON
AFOAT-1 WASHDC
CO NAVSTA Midway
COMWESTSEAFRON
VP-29
VW-1

AUTHENTICATED:

s/A. R. Olsen
t/A. R. OLSEN
Flag Secretary

AEC AIRBORNE MONITORING FLIGHT SCHEDULE

Health and Safety Laboratory, New York Operations Office, AEC (H&SL NYOO)

1. KWAJALEIN FLIGHT PATHS (D PLUS 1 DAY)

ABLE	BAKER	CHARLIE
KWAJALEIN	KWAJALEIN	KWAJALEIN
LAE	NAMU	MOKIL
UJAE	AILINGLAPALAP	PONAPE
WOTHO	NAMORIK	UJELANG
BIKINI	EBON	KWAJALEIN
AILINGINAE	JALUIT	
RONGELAP	MILI	
RONGERIK	ARNO	
TAONGI	MAJURO	
BIKAR	AUR	
UTIRIK	MALOELAP	
TAKA	ERIKUB	
AILUK	WOTJE	
LIKIEP		

2. GUAM FLIGHT PATHS (D PLUS 1 TO D PLUS 4 DAYS)

DOG	EASY	FOX
GUAM	GUAM	GUAM
ROTA	NAMONUITO	GAFERUT
AGIGUAN	TRUK	FARAULEP
TINIAN	LOSAP	WEST FAYU
SAIPAN	NAMOLUK	IFALIK
FARALLON DE MEDINILLA	LUKUNOR	WOLEAI
ANATAHAN	SATAWAN	EAURIPIK
SARIGUAN	KUOP	PALAU
GUGUAN	PULAP	NGULU
ALAMAGAN	GUAM	YAP
PAGAN		ULITHI
AGRIHAN		GUAM
ASUNCION		
MAUG		
FARALLON DE PAGAROS		

Inclosure 5-c

3. HAWAIIAN FLIGHT PATHS (D PLUS 2 TO D PLUS 6 DAYS)

GEORGE	HOW	ITEM
PEARL	MIDWAY	PEARL
MIDWAY	PEARL	LANAI
(Over south beaches enroute passing all islands in HAWAIIAN Chain)	(over north beaches enroute passing all islands in HAWAIIAN Chain)	KAHOOLAWE
		HAWAII
		MAUI
		MOLOKAI
		PEARL
		(Over southern beaches enroute Hawaii and northern beaches on return to Pearl)

INCOMING MESSAGE

FROM: CINCPACFLT DTG 120238Z FEB 1954

TO: CJTF SEVEN ENIWETOK

1. Subject is AFOAT-1 CASTLE Participation. AFOAT-1 letter OPNS 370.009 dated 23 Dec 53 and CJTF SEVEN letter J-3/729.3 dated 11 Dec 53 refer. In accordance with my concept as stated in paragraphs 7.a.2. and 7.f. CINCPACFLT letter serial 001355 of 31 Oct 53, consider best use AFOAT services can be obtained by extending JTF tracking capabilities in downwind sector. Such use will provide more information to following sources for purposes indicated:

a. To CJTF SEVEN in capacity of advisor to CINCPACFLT on special hazards and danger areas incident CASTLE.

b. To JTF SEVEN Radsafe evaluation center for definition of predicted cloud trajectories in areas outside the test site.

c. To AEC Project Officer in JTF SEVEN for more effective coordination of worldwide fallout monitoring program.

2. For above reasons propose following AFOAT participation:

a. Cloud track in downwind sector beyond termination of JTF SEVEN effort as directed by CJTF SEVEN.

b. Time duration and region based on post shot developments as reviewed by CJTF SEVEN.

c. Precision similar to efforts of JTF SEVEN aircraft.

d. Message reports of significant intensities to CJTF SEVEN. Readings below 10 mr/hr considered insignificant and will be expressed as negative reports. Such reports should include information which confirms or otherwise aids CJTF SEVEN forecast atomic cloud trajectory for initial 72-hour period after detonation.

3. Foregoing pursuant my concept that all reports pertinent to special hazards and danger areas incident CASTLE will be evaluated by CJTF SEVEN in formulation of appropriate safety advisories to CINCPACFLT. Separate reports from AFOAT or other agencies to CINCPACFLT not desired. Propose CJTF SEVEN coordinate details with AFOAT.

4. (New but related subject) Intensities below 10 mr/hr recorded by AFOAT aircraft during normal routine missions may provide valuable documentation for extending AEC knowledge of worldwide fallout patterns even though insignificant for Radsafe purposes. If AEC Project Officer desires such information consider he should arrange handling via mail.

5. Request message comment.

INCOMING MESSAGE

FROM: CINCPACFLT DTG 190225Z FEB 1954

TO: HICOMTERPACIS

INFO: CNO, CINCPAC, CJTF 7, CTG 7.3

1. During forthcoming tests at Eniwetok and Bikini, AEC desires automatic monitoring equipment be placed at Ujolang. This equipment will be battery operated and unattended. Purpose is to continuously record intensity of radioactive particles if any fallout occurs incident to atomic detonations. Occasional Ujolang visits by Navy PBM aircraft will be necessary to check and read equipment.

2. Preliminary safety advisory from CJTF SEVEN indicates following predictions on probability of fallout hazards in Trust Territory:

a. Remote possibility at Ujelang.

b. Very remote at other islands in vicinity of shot sites.

3. Consequently no evacuations of any populated islands are planned. In event post-shot developments indicate desirability of certain health and safety measures for native inhabitants of certain islands, assistance of Marshalese interpreters and administrative personnel from Majuro District Office or Ebey would be required by CJTF SEVEN on short notice.

4. Request your concurrence in implementing Ujelang installation as outlined above. Further request planning arrangements be made for provision of assistance by District Administrator in event requirement materializes.

5. CINCPACFLT will keep you informed regarding any unusual developments requiring any action by Trust Territory personnel.

Incl 8 to TAB "C"

INCOMING MESSAGE

FROM: CINCPACFLT DTG 201857Z Feb 1954

TO: COMNAVMARIANAS, COMHAWSEAFRON

INFO: CJTF 7 ENIWETOK, CTG 7.3, CINCPAC, CNO

Shortly before each CASTLE detonation, CJTF SEVEN will issue message advisories concerning anticipated radiological impact on air and surface routes including recommendations relative to closing routes. During two days preceding each shot, TG 7.3 Security Aircraft will make reconnaissance flights in significant fallout quadrant out to 600 miles to clear itinerant shipping from predicted cloud passage area. Message advisories for information. On basis this information implement action to divert shipping from possible hazardous areas and assist mission TG 7.3 aircraft as practicable.

Incl 9 to TAB "C"

INCOMING MESSAGE

FROM: CINCPACFLT DTG 250244Z FEB 1954

TO: CJTF 7 ENIWETOK

INFO: CINCPAC

1. Subject is safety measures and radiological hazards in Marshalls during CASTLE. Your letters both marked J-3/729.3 of 11 Dec 53 reference.

2. Following comments pertain safety letter to CINCPAC on paragraphs indicated:

a. Reference 2a. In the event compelling post shot reasons require temporary evacuation of natives, desire CTG 7.3 retain operation control of ships and delegate mission to unit commander or ship commanding officer as appropriate. Limited additional assistance including PBM type aircraft can be made available by NAVSTA Kwajalein. My 190225Z also refers.

b. Ref. 2c, 2d and 3c. My 201857Z refers. Have also notified CAA Administrator of possible interference with Wake air routes. Expect your advisories will allow sufficient interval for notification CAA and his subsequent dissemination to effected air lines for requisite action.

c. Reference 3a, my serial 0013 of 11 Feb 54 provides for airborne surveys of significant Pacific Islands.

d. Reference 3b. Following measures available at Wake and Johnston vice film badge survey. AEC NYKOPO has continuous ground monitoring equipment at Wake for transmission daily reports to AEC Project Officer your staff. Johnston within VW-1 airborne survey capability established for Hawaiian area. For significant populated Marshall Atolls desire maximum coverage as necessary be made with VP-29 airborne surveys. If such surveys indicate slightest adverse conditions, desire you supplement with ground checks utilizing appropriate means available. For this purpose consider Kwajalein aircraft augmented by JTF 7 units wherever necessary.

e. Reference 3d. In accordance with my 120238Z desire AFOAT assistance only as coordinated through you.

3. Following comments pertain your Marshall Radsafe letter to CINCPACFLT on paragraphs indicated.

a. Reference 6c. In view of numerous populated atolls in Marshalls consider impractical to conduct film badge surveys to provide negative documentation. Consider my paragraph 2d above is only acceptable solution.

INCOMING MESSAGE DTG 250244Z FEB 1954 FROM CINCPACFLT CONTINUED:

b. No additional comments on this reference except notation that each item my paragraph 2 above also applies to corresponding items.

4. New but related subject. Request you address safety advisory messages action to CINCPACFLT and info to CINCPAC COMNAVMARIANAS and COMHAWSEAFRON.

OUTGOING MESSAGE

FROM: CJTF SEVEN ENIWETOK ATOLL MI DTG 260010Z FEB 1954

TO: CINCPACFLT PEARL TH REF: CINCPACFLT (SECRET) MSG: DTG 120238Z FEB 1954

1. Your DTG 120238Z FEB received 24 Feb 54. Consider AFOAT-1 reports for evaluation health hazard Pacific area no practical value since information based on aerial contacts at far distances. AEC Project Officer will furnish CJTF SEVEN actual ground readings. These are considered only reliable basis JTF SEVEN advisories to you. Your concept that CJTF SEVEN only Radsafe advisor to CINCPACFLT is acceptable. Understand this concept cancels Radsafe report required paragraph 4h your letter, serial 00113, dated 11 Feb 54 to this headquarters reference support AEC fallout program. AEC Project Officer advised of contents your message and will take separate action to obtain information from AFOAT-1 as required.

2. (New subject) Reference paragraph 5b above letter, JTF SEVEN is supporting AEC Project Officer as requested except as modified by your substitution of VW-3 for Marianas and Western Carolines in lieu of VP-29.

Incl 11 to TAB "C"

INCOMING MESSAGE

FROM: CINCPACFLT DTG 270033Z FEB 1954

TO: CJTF SEVEN ENIWETOK ATOLL MI

Concur your 260010Z FEB 54. Desire you include summary of airborne monitoring flights subsequent each shot in your scheduled radsafe advisories.

Incl 12 to TAB "J"

OUTGOING MESSAGE

FROM: CJTF SEVEN ENIWETOK ATOLL MI DTG: 280700Z FEB 1954

TO: CINCPACFLT PEARL TH

Your 250244Z received. Paragraph 2a your message relayed to COMNAVSTAKWAJ for info and to CTG 7.3 for confirmation previous verbal agreements.

M/R: CINCPACFLT 250244Z refers to msg to CJTF SEVEN commenting on CJTF SEVEN letters, one to CINCPAC and one to CINCPACFLT, both subject: "Safety Measures During Operational Phase of CASTLE", both dated 11 Dec 53. Para 2a subject letter to CINCPAC states that JTF SEVEN shipping will be made available to CINCPAC if necessary for native evacuation. CINCPACFLT 250244Z states CINCPAC desires commander or ship commanding officer as appropriate. CINCPACFLT's msg also covers several minor details of previous plan as outlined in above letters to CINCPAC and CINCPACFLT.

INCOMING MESSAGE

FROM: CINCPACFLT DTG 190356Z MAR 1954

TO: COMPHIBPACFLT, CRUDESPAC, COMHAWSEAFRON, COMSERVPACFLT, COMSUBPAC, COMMINPAC, COM AF PACFLT, COMNAV FORCES MARIANAS

INFO: CJTF SEVEN ENIWETOK, COMSTSPAC SFRAN, COMSTS WASH DC, CNO COMSTSMIDPACSUBAREA, CTG SEVEN PNT THREE

Until further notice all PACFLT vessels except those assigned to JTF SEVEN, entering the circular area within 450 nautical miles from a point 12 degrees north latitude, 164 degrees east longitude will insure that casualty film badges and/or phosphor glass dosimeters (DT 60/PD) are worn by 5 percent of the personnel on board until the vessel departs from the aforementioned area. When not being worn, badges and dosimeters will be returned to shipboard storage without processing. Processing will only be accomplished when specifically directed by CINCPACFLT. Purpose of this precautionary measure is to permit documentation for negative or positive information incident to fallout phenomena and does not imply that exposure is expected. Operation control authorities have separate instructions to effect advanced diversions from potentially hazardous areas. CINCPACFLT instructions 06470. dated 14 March 1953 basically refers. Instructions for vessels assigned JTF SEVEN as prescribed by CJTF SEVEN. For COMSTS, recommend application to your MSTS ships as practicable.

TAB "D"

FALL-OUT FORECASTING TECHNIQUES

3 Incls:

1. Basic Techniques and Future Studies.
2. Long-range Forecasting by Modified Technique Developed after BRAVO. (Forecasting of the 10r Isodose Line)
3. Close-in Forecasting by New Techniques Developed after BRAVO.

BASIC TECHNIQUES AND FUTURE STUDIES

The basic fall-out forecasting technique used on Operation CASTLE was an adaptation of the method outlined in Appendix F of the Effects of Atomic Weapons, revised September 1950. Essentially, this method computes the rectangular coordinates on the surface at which particles will fall from a series of heights, provided the winds at these heights are known and the time of fall can be approximated from a consideration of particle size distribution. The method was simplified to a considerable extent by the successful application of graphical vectorial solutions to the equations and the assumption of workable empirical values of particle size (i.e. time of fall parameters) following the DOG Shot of Operation GREENHOUSE. A description of the technique was contained in the GREENHOUSE Meteorological Report. More recently, a detailed graphical solution based on the GREENHOUSE method, was published in Air Weather Service Manual 105-33, "Radioactivity Ground Fall-out Plot", dated 1 August 1951, revised as AWSM 105-33 "Radioactivity Fall-out and RADEX Plots", dated 2 June 1952 and being currently revised again. All of the above are essentially the same method, differing primarily in technique of application and in refinement of computations and assumptions. All gave reasonably accurate results prior to CASTLE, including an apparent compatability with the shots of Operation IVY. Elsewhere in this report, there are discussions devoted to assumptions, theories and apparent proofs relative to the validity of pre-CASTLE forecasting techniques to cope with large yields. Some of the factors have been resolved on CASTLE; others have not. The predominant unknown that has been at least partially resolved on CASTLE is that arising from questions of the variation of the efficiency of this type of fall-out forecasting with increased yields. Prior to CASTLE, the only shots were those fired under rather unusual circumstances. The first, was fired on the trailing edge of a typhoon with a consequent extremely favorable wind pattern, with all levels of the cloud moving to the northeast but with no means whatsoever of assessing the actual fall-out pattern on the water. The second, IVY MIKE was also fired under unusual and highly favorable wind conditions, the system being such that all fall-out was apparently in the northwest quadrant from the ENIWETOK ground zero. Again, no means of assessing the actual downwind fall-out pattern were available. The third, IVY KING was an air-burst at approximately 1,500 feet, and, although detonated under a wind system considered unfavorable for a surface shot at ENIWETOK, was characterized by the usual small amount of fall-out associated with air bursts.

In theory, there appeared prior to CASTLE no reason why the system should not be adequate to cope with the scheduled shots, except that the efficiency of the system to predict fall-out beyond about six hours was seriously questioned and the entrapment characteristics of the tropopause level were not understood even in general terms. For CASTLE it was assumed that the period of fall-out significant from a test and industrial standard point of view would be on the order of twelve hours. It was also assumed that confidence could not reasonably be placed in significant trapping of

debris by the tropopause unless definite proof of such a mechanism was available. As a consequence, the techniques described above were used with confidence up to about six hours, and examined in their relation to the long-range forecast air particle trajectories for times beyond six hours. This employment was later expanded into a more detailed and formal technique developed subsequent to the third shot and employed thereafter in the series. (See Incl 2)

The method of elliptical approximations developed following the TUMBLER/SNAPPER series in Nevada (and used with remarkable success on UPSHOT/KNOTHOLE) was used on CASTLE for a better appreciation of the degree of contamination and the extent of the forecast fall-out areas. Due to yield scaling considerations, and the unique meteorological differences between the Nevada and the Pacific proving grounds, confidence in this method for the first shot of the CASTLE series was low. In addition, although this method has certain practical and appealing features, in its delineation of a picture of the fall-out pattern on the ground, it is no less restricted to the ground zero wind system and the stability of these winds, than the methods described heretofor.

CASTLE use of the existing fall-out forecasting methods was substantially as follows:

a. Vector solution. This method was applied by the vectorial addition of winds from the surface to maximum height, all vectors normalized to 5,000 feet per hour for convenience in computations, and with the vector lengths proportional to the wind speed in knots. Since the surface wind and the areas contiguous to GZ in the PPG are essentially at zero elevation, no correction was necessary for the so-called "average fall-out surface" elevation. Winds were normally plotted for each 2,000 foot levels from two thousand feet to twenty thousand feet and for every five thousand feet levels up to seventy thousand feet. Above seventy thousand, due to the relatively stable wind directions, ten thousand foot levels were plotted as a normal rule. The 2,000 foot intervals were used in the lower tradewinds primarily to smooth out the wind vector diagram for these levels which are critical from a close-in fall-out viewpoint. For this purpose, the 2,000 foot vectors were normalized by plotting vectors of a length two-fifths of the wind speed in knots (i.e. 2,000/5,000 of a full hour wind vector). Ten thousand foot levels were similarly treated, plotting 10,000/5,000 or twice a full hour wind vector. In this technique, the 2,000 foot level was assumed to represent the average wind between the surface and 2,000 feet, the 4,000 foot level was assumed to represent the average wind between 4,000 feet and 2,000 feet, etc. The addition of closing vectors between the ground zero (initial point of the first vector) and each successive altitude provided the necessary resultant winds from each level, and consequently, the line on the ground on which fall-out should occur from the levels involved. Computations of time of arrival of fall-out and area of fall-out followed the same pattern as presented in AWSM 105-33, consisting basically of dividing the resultant winds into hourly increments depending

upon the altitude involved and the delineation of a sector by the limiting resultant wind vectors. A fifteen degree sector was added to each side of the fall-out area to provide a factor of safety for diffusion, instability of the pattern and wind variation with time and distance from H-Hour and GZ. Since the wind vector diagram (or hodograph) was normalized to 5,000 feet per hour, the value of any resultent wind in hours was determined by the altitude for which it was plotted divided by 5,000. Since equi-time lines taken directly from the hodograph represented a fall-rate of 5,000 feet per hour (approximately the rate of fall of a 100 micron particle), this distance was increased by doubling, tripling, etc., to consider particle sizes of less than 100 microns. For the first shot, particles down to 70 microns were assumed to be significant. This amounted to considering populated areas at distances double the total resultant wind vector at each altitude. Subsequent to the first shot, eighteen to twenty-four hour fall-out periods and distances represented by tripling and quadrupling the total resultant wind vector were considered. Considerations of land surface and water surface shot characteristics materially modified these assumptions subsequent to the second shot, the modifications tending toward a reduction to distances represented by not more than twice the total resultant wind vector for significant health hazard fall-out, and at least twenty-four hours for fall-out of significance to test and industrial standards. It should also be mentioned that the hodograph, or wind vector diagram, being the basic framework of both the elliptical approximation method of fall-out forecasting and the rectinlinear vector method, was found extremely useful in the graphic presentation of the progressive wind observations and forecasts made daily during the operation. Consequently, "raw" hodographs were continuously used by Radsafe as a measure of the "pulse" of the daily trends in the wind patterns and in the graphic presentation of the wind picture during command briefings. A complete series of daily hodographs has been prepared and reproduced covering the period February through May 1954 for documentation and future convenient study of interested personnel. (See also Tab I.)

b. The method of elliptical approximation of the fall-out pattern mentioned above is covered in USAF ARDC Report No. C3-36417, November 1953, Radioactive Fall-out from Atomic Bombs, as amended by USAF ARDC Report No. C4-18098, March 1954 (relative to CASTLE BRAVO Fall-out and allied implications). Essentially the method starts with the "raw" forecast hodograph. With this as a basis, ellipses are drawn with the portions of the hodograph between major shear levels as approximate major axes. Minor axes are determined in accordance with the angular shear existing between major shear levels and in accordance with the following empirical rules:

(1) If the wind shear is less than 10 degrees for the levels in question, the minor axis is 1/8 to 1/4 of the major axis.

(2) If the wind shear is greater than 10 degrees but less than 120 degrees, the minor axis is 1/2 of the major axis.

(3) If shear is greater than 120 degrees, the ellipse becomes a circle with diameter equal to the average axis of the hodograph between the shear levels.

(4) Perturbations of the ellipses are determined by the shape of the hodograph, i.e. dependent also upon the angular shear.

An overall envelope is placed around the collection of internal ellipses, its dimensions and perturbations determined essentially by scaling of yield and angular shear respectively. Internal ellipses are placed within the larger inter-shear level ellipses, again in accordance with empirical rules. The net result is an approximation of the infinity doses deposited at the contour points outlined by the ellipses and their envelope. Number values are placed on the contours by yield and area scaling of emperical values observed on past shots.

Other work:

a. A method, more suited to military and civil defense target analysis studies than to test operations, is delineated in Technical Analysis Report - AFSWP No. 507, Radioactive Fall-out Hazards from Surface Bursts of Very High Yield Nuclear Weapons, May 1954. This report is based on ground surveys made following the BRAVO shot, and is an excellent study of the relatively significant long-range effects of fall-out. However, simplifying assumptions in the application of the system, although apparently adequate from the health hazard point of view for which the report was written, are not compatable with forecasting with test and industrial standards as limiting criteria. An extension of AFSWP 507 is contained in AFSWP 603, A Summary of the Effects of Weapons in the Eniwetok Range, June 1954, covering the entire field of weapons effects including fall-out.

b. Future studies: Studies of the whole mechanism of fall-out and means of forecasting its degree and extent are being conducted by the Rand Corporation under contract with the USAF and AEC, the Meteorological Branch of the Army Signal Corps, AFSWP, the AF Cambridge Research Center, in conjunction with Detachment #1, AFCRC, APO 953, under Dr. C. E. Palmer, and jointly by Dr. G. L. Felt (J-Div LASL), Major O. W. Stopinski, (to be assigned to LASL), and Dr. T. N. White (H-Div LASL). An indication of the scope of the studies being conducted by the LASL personnel are indicated in the preliminary reports (See Incls 2 and 3 hereto) on the basic work done at the PPG during the last three shots of the CASTLE series. A report on the Rand Corporation study was published in July 1954. A report on the Army Signal Corps study was scheduled for completion by 15 August 1954. Studies of the remaining groups are expected to be more or less continuous for some time; no periodic report schedule has been established. In addition, a plotting device and manual based essentially on the AWSM 105-33 technique, is in preparation by the Naval Aerological Service.

LONG-RANGE FORECASTING BY MODIFIED TECHNIQUE DEVELOPED AFTER BRAVO

(FORECASTING OF THE 10R ISODOSE LINE)

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Introduction:

The problem of long-range fall-out from very large devices (megatons) was first examined prior to Operation IVY. At that time the methods of analysis were based on a simple theoretical model devised to evaluate the hazards from the Jangle shots and on the empirical results from low-yield tests in Nevada. Neither source was truly applicable in detail to MIKE, a fact well-known at the time, but the general result, as we know from ______ was correct; i.e., fall-out from MIKE under adverse conditions could have been very severe at distances of 200 to 300 miles. The actual conditions on MIKE-Day were, of course, favorable but at the same time rather unusual in that the location of the main fall-out was well clear of all populated areas.

The rare occurrence of ideal conditions, the length of the CASTLE operation, and the very evident hazards from the devices made necessary a re-examination of the problem of fall-out. In the field such a re-examination could be very crude at best, geared as it was to the immediately practical aim of operational forecasting. It was necessary to devise a system of forecasting simple enough to provide results based on the latest possible weather information, both observations and forecasts, conservative enough to guarantee no repetition of the unfortunate results of ______ and yet daring enough to enable one to take advantage of weather conditions different from those known to be ideal (no northern components from surface to 100,000 ft and axis of fall-out between about 315° and 045°).

The treatment generally used in Nevada with moderate success was pretty clearly not well suited to fall-out forecasting at the Pacific Proving Grounds except possibly under the condition of "deep easterlies", when all wind vectors from the surface up are easterly (an alternate "ideal" situation incidentally for Eniwetok Atoll but not for Bikini). The basic difficulty with using the Nevada system for analysis of the effects of large devices in the Pacific is that the wind structure in the Pacific is not primarily unidirectional in the pertinent altitude range. The usual fall-out pattern in Nevada is a narrow band, broadened at times by the presence of light and variable winds and by the occasional presence of abnormally great directional shear but still confined to a small sector. This general character is not often found in the Pacific, where the directional shear is almost always very great just above the east-northeast flow in the low altitudes and again at the tropopause (usually about 55,000 to 60,000 ft). In the Pacific the sector which includes all the distant fall-out is very frequently 180° and occasionally even greater.

INCLOSURE #2

While the sector is very large in the Pacific it is not true that the fall-out is uniformly distributed within it, and it therefore becomes necessary to look closely at the angular distribution of fall-out as well as the radial. It is this new factor in the analysis which makes the CASTLE system differ fundamentally from the Nevada system. It does not necessarily follow that the Nevada system should not also have this feature since there are evident failings there which may perhaps be removed in this way.

The Dose Index

The first step in the new system of analysis was to calculate the relative dose at various points about the origin for a given wind structure. The mechanics of preparing the isodose plots will be decribed in the followin sections. Here we shall discuss the assumptions and general principles of the method. The assumptions used in the calculations are listed below:

(1) The activity is uniformly distributed in height. This assumption is obviously a poor one and was subsequently altered to emphasize the middle region of the cloud and to depress the stem and the top. In the first plot this modification was applied at the plotting stage rather than at the calculational stage.

(2) The distribution of particle sizes is uniform. This assumption also is not true but is justified by several arguments. From our point of view — distant fall-out — the number of particles two feet in diameter relative to the number 100 microns in diameter makes not the slightest difference since the former all fall in the region of the crater anyway. On the other hand the relative number of very small particles is equally uninteresting since those do not fall quickly enough to affect the results significantly. What we have done in effect is to assume a "white" distribution for simplicity and to restrict the region of validity to distances between approximately fifteen miles and a couple of hundred miles from the origin. Again, in the absence of any detailed information on the real distribution, the assumption we have made is probably the safest.

(3) The amount of activity deposited by an active particle is proportional to its area. One may fairly argue that in some cases the activity should be proportional to the particle volume. The choice of area dependence is based on the idea of plating on molten solids and on the idea of scavenging by water droplets.

(4) The total activity is proportional to the total yield and decays at $t^{-1.2}$.

(5) The particles settle by Stoke's law. This assumption is always challenged but no suitable substitute has yet been suggested. In the range of particle sizes of interest it is probably as good a law as any modification of it.

(6) The area at the surface covered by particles falling from a given height is proportional to the square of the time of fall. This assumption expresses the fact of divergence which may arise from any number of reasons. No numerical value is assigned to the divergence.

(7) The net radial distance that a particle travels is proportional to the time of fall.

With the above assumptions one obtains the dose index in the following inelegent way. At a given point "P" on the surface (Fig. 1) active particles can arrive from certain discrete altitudes of the cloud determined by the intersection with the hodograph of the radius vector from ground zero through the point. In the example these are the altitudes 79,000 ft at "A" and 39,000 ft at "B". The hodograph is customarily drawn for a fall rate of 5,000 ft per hour so that particles with that fall rate which start from 39,000 ft at nominally zero time will land at "B" in 7.8 hours. These particles will have a definite diameter "d". We have said that the activity brought down by any particle is proportional to its area; i.e., the dose index "D" contains a factor "d^2".

The remainder of the argument concerns the time. Two other assumptions contain time terms, the natural decay and the area of deposition. Now the dose rate is expressible in activity per unit area. For example, one megacurie per square mile is roughly equivalent to 3 r/hr about 3 ft above a fission fragment deposition. The dose rate is therefore expressible as

$$\text{rate} \propto \frac{a}{A} \propto \frac{t^{-1.2}}{t^2} \qquad (1)$$

and the integrated dose, apart from other factors, is expressible as

$$\text{dose} \propto t^{-2.2} \qquad (2)$$

We chose to define the dose index as

$$D = \frac{d^2}{t^2} \qquad (3)$$

where "d" is the particle diameter in microns and "t" is the time at which it arrives in hours. In the event that particles arrive from two heights as indicated for point "P" in Fig. 1, one merely adds the two indices arithmetically. We have felt, in view of the crudeness of these arguments, that very little would be achieved by keeping the power of "t" at -2.2 and have used -2.0 instead.

One will note that in this form the dose index does not yet contain Stoke's law but states merely that particles of size "d" arrive at time "t". The use of Stoke's law and some of the other assumptions permits the dose index to be written in a wide variety of alternate forms. Stoke's law states that the terminal rate of fall is proportional to the area of the particle. In our case the terminal rate is reached so quickly that one may write

$$\frac{h}{t} = K\, d^2 \tag{4}$$

where "h" is the starting height, "t" is the time of fall, "d" is the particle diameter and "K" is a constant of proportionality containing the density, the viscosity, and numerical factors. The viscosity, incidentally, is temperature dependent, but the variation is small compared to the other uncertainties in this system and we have chosen to keep the viscosity constant. Substitution of equation (4) permits one to write the dose index as

$$D = \frac{h}{K} \cdot \frac{1}{t^3} \tag{3a}$$

and further use of assumption (7) above permits the form

$$D = \frac{h}{K'} \cdot \frac{1}{R^3} \tag{3b}$$

where "K'" is some new constant and "R" is the radial distance along a bearing from ground zero.

Numerical values of the dose index can be computed from any of the forms of equation (3) with the proper selection of units.

We defined the numerical value of the dose index as the ratio of the square of the particle diameter in microns to the square of the time of fall in hours. In those units the dose index is of the same order as the dose in roentgens from a 10-megaton yield as determined by a rough match with data. The adjustment to other yields in the megaton range is made by direct proportionality as indicated in assumption (4).

Preparation of the Plot: Static Case

- We proceed now to describe the method of constructing the isodose contours for the simpler case of the static hodograph. The static hodograph presents a plan view of the vertical structure of the forecast winds at zero time and at the origin. Fig. 1 is a sample hodograph constructed from data in Table I. The criticisms against the static hodograph are that it should not be expected to persist unchanged even at the origin throughout the time of fall-out, and that it does not in principle apply at all to points displaced from the origin. These criticisms become more important as one attempts to forecast the low-level isodose lines which are established at considerable distances from the origin and many hours after shot time. The static hodograph does, however, provide a useful guide and has the virtue that a plot can be prepared from it very quickly indeed.

Using the sample hodograph of Fig. 1 let us compute the dose index for point "P" at 40° and 60 nautical miles from ground zero. There will be two components for "P" and all other points along the radius from "Z" through "P". From the hodograph the intercept heights and distances are 79,000 ft and 45 miles at "A", and 39,000 ft and 73 miles at "B". As mentioned above the total index for "P" is the sum of the indices computed from the two intercepts.

Let us consider first the index from intercept "A". Particles which fall at "A" on the surface start at 79,000 ft above Zero. As they fall to 65,000 ft they travel westward approximately 75 miles. In falling the next 5,000 ft they travel approximately 10 miles southwest. Thereafter they swing around through the south, travel eastward between 50,000 and 40,000 ft, gradually turn to the northeast, and at about 15,000 ft settle into the surface trades for the last 20 miles of westward travel to point "A". Since the hodograph is drawn for the convenient rate of 5,000 ft per hour the particles arrive at "A" 15.8 hours after zero. Particles arriving at "P" from 79,000 ft must spend a slightly longer time in each altitude layer; their trajectory is similar to that for the faster-falling particles but is expanded. The relative time for particles to arrive at "P" compared to "A" is given by the ratio of the vector sums or by the factor 60/45 = 1.33. The time in hours is therefore 21.1 hours.

Now we have assumed a relationship between fall rate and particle diameter given by Stoke's law. Specifically, for land shots at the Pacific Proving Grounds, we assume that 75-micron particles settle at 4,000 ft per hour. Particles arriving at "P" from 79,000 ft settle at 3,740 ft per hour and are therefore slightly smaller than 75 microns. Stoke's law gives 72.4 microns. Using equation (3) with the numerical values 72.4 microns and 21.1 hours one obtains a dose index at "P" from the intercept "A" of approximately 12.

A similar computation for the dose index from intercept "B" gives the much higher value 208. The total index at "P" is therefore 200. This means that for 10 megatons one would expect an integrated lifetime dose of 220 roentgens in the vicinity of point "P".

It is obviously time-consuming to compute the index for a large number of points in the field in the way just described. In order to speed up the computation of dose indices the nomogram in Fig. 2 was constructed from an alternate form of the dose index equation. The most suitable form is

$$D(\theta, R) = \frac{v_o^3}{K_s h_o^2} \left(\frac{R_o}{R}\right)^3 \tag{3c}$$

where "v_o" is the hodograph fall rate (5,000 ft per hour), "h_o" is the intercept height in feet, "K_s" is the Stoke's law constant (4,000/5625 in our units), "R_o" is the intercept radius in miles, and "R" is the distance in miles to a point on the bearing "θ". One should note that for constant "θ" the intercept height and distance are also constant and that the dose index along this bearing decreases as "R^{-3}". Consequently if one can determine the dose index at one point along the bearing the indices for other points can be read very quickly from a straight line of slope -3, on log-log graph paper. The obvious point to determine an index is at "R_o". For all bearing the dose index at $R = R_o$ is determined by the intercept height alone. It becomes very simple therefore to make a suitable nomogram by drawing a line of slope -2 which gives the dose index "D_o" for $R = R_o$. The doses at any "R" are then obtained by placing a straightedge with slope -3 through the point "D_o, R_o". For quick reading several arbitrarily spaced lines of slope -3 have been drawn in Fig. 2.

Using again the sample wind structure of Fig. 1 one obtains the index for point "P" from the intercept "B" by entering the nomogram at h_o = 39,000 ft at the top of the page, coming down to the unweighted height line at index 110, moving left to a point above the distance R_o = 73 miles, then up a line of slope -3 to index 210 above R = 60 miles.

The nomogram in Fig. 2 has two height lines, the curved one corresponding to a weighted height distribution. This second curve is believed to be somewhat more realistic inasmuch as it reduces the weight of the very low and very high parts of the cloud and increases the weight of the middle cloud. This rather general weighting is based entirely on observation and experience and is not derived analytically.

With a very little experiense in the use of the nomogram one can from the hodograph prepare the plot shown in Fig. 3 in approximately one-half hour. The weighted height line has been used in this plot.

Preparation of the Plot: Dynamic Case.

For operational use a 10 R dose is a handy dividing point between "dangerous" and "harmless" levels. A dose index of the order of 10 is therefore perhaps the most important of the family of lines. An index of 10 is however established at rather late times — it is completed for the 90,000 ft level at approximately 23 hours — and its extreme point may be a considerable distance from the origin. Consequently it is in general desirable to make appropriate corrections for time and space changes in the wind structure.

The method devised is based on the same general assumptions as for the static case and is again simple enough to permit the preparation of a plot in a short time. The complication here was that a complete weather analysis of the entire area could not be made every few hours by the limited crew at the Eniwetok Weather Central. Consequently it was necessary to have a forecaster present to make appropriate corrections as the plot developed.

Since in the dynamic case the trajectories of particles of different sizes falling from the same height are no longer similar, the terminal points do not fall along a straight line running out from the origin. The index falls off inversely as the cube of the distance along the line of terminal points instead of along a line of constant bearing.

It is possible but at present very time-consuming to compute the lines of terminal points for a set of altitudes complete enough for an adequate plot. The best that could be done in the time available was to locate the 10 R point for about a dozen altitudes and base the 10 R line on these points alone. A complication arises when the points fall at different distances on roughly the same angular bearing. This result corresponds to a contribution from two or more altitudes and means that the 10 R line must be drawn some distance beyond the outermost calculated point. The adjustment is easy to make approximately by a simple application of the inverse R^3 relation to the inner points to find the contribution at the outermost and a second application of inverse R^3 to the sum. To take into account the height weighting one locates the terminal point and then contracts or expands radially, again by inverse R^3. These approximate methods are an unhappy feature of the system but are necessary if the plot is to be completed in a reasonable time. We were unable to discover any quick, reliable analytic or graphical method of making these adjustments more precise.

The mechanics of locating the 10 R points (before any adjustments) are straightforward enough. The dose index equation (3) gives the dose in R for 10 megatons. For a predicted yield different from 10 megatons one may write a dose equation

$$I = \frac{W}{10} \cdot \frac{d^2}{t^2} \qquad (5)$$

where "I" is the dose in roentgens, "W" is the yield in megatons, and "d" and "t" are defined as before. This equation follows, of course, from assumption (4). The form (5) is not convenient for calculation, since in the construction of a trajectory for a falling particle one is concerned only with the time the particle spends in a stratum characterized by a fixed mean wind. It is convenient then to introduce Stoke's law and to solve equation (5) for the fall rate "v". The result is

$$v = \sqrt[3]{\frac{10\ I\ K_s\ h^2}{W}} \qquad (5a)$$

where "K_s" is the constant 4000/5625, "h" is the starting height in feet and the unit of "v" is feet per hour. The time spent in a given stratum "Δh" is then

$$\Delta t = \frac{\Delta h}{v} \; . \qquad (6)$$

Equations (5a) and (6) were used to prepare a worksheet listing the strata, times in the strata, and accumulated times from the start to the strata. Forecast mean winds were then entered on the work sheet as the trajectory plots were made and the times and space locations became known. In the actual cases the computed changes in wind structure were never very significant and the resulting plots differed little from those made from the static hodograph. The dynamic system does, however, have the capability of handling a rapidly changing situation should it appear.

Conclusions:

The fall-out forecasting systems described above have a large number of very obvious deficiencies which one would hope to remove by the next operation. For example one would hope to include a good representation of the particle size distribution for both land and water shots. The question whether area or volume of a particle is more significant for the deposition of activity should be investigated. A careful estimate of the height distribution of the activity should be made. Some attention should also be given to the effects of finite lateral cloud dimensions and to the spreading of the cloud. These are points which will refine the system.

Dr. Tom White of LASL began to make such refinements during CASTLE in an attempt to remove one outstanding defect of this system, its inherent inability to reveal any detail near the origin. His method is described in a separate appendix.

Two difficulties with the system cannot be removed at all. The case where the hodograph passes directly over the origin is not unlikely and gives embarrassing results, since $R_0 = 0$ and the dose index vanishes except at the origin. This result is at least circularly symmetric. The other awkward case is that in which one or more elemental wind vectors is radial, since one then has a continuous altitude range contributing to the dose index along a bearing in place of one or two discrete altitudes. This is in reality precisely the kind of wind structure which leads to very intense narrow bands, but the system as set up cannot estimate the magnitude of the dose index along such a bearing. One could perhaps handle this situation by revising the method such that each 5,000-ft altitude interval made a contribution as determined by the mean height of the interval along a bearing line through this mean height. Such a change would introduce difficulties in evaluating the contributions at one point from several heights since the bearing lines through the mean heights would not in general coincide.

One difficulty will continue to plague us even with any sort of refined system. At this time it is very difficult to obtain a weather forecast precise enough to justify the effort which must be put into a good fall-out forecast. Because of the inherent uncertainties in weather forecasting one is tempted to conclude that a refined system of fall-out forecasting will for the time being be most useful for post-shot analysis and that a detailed fall-out forecast based on a normal weather forecast would be misleading. The weather forecasting presently available is of the highest quality but the cumulative errors resulting from small variations about the forecast mean winds can result in a pronounced change in the fall-out pattern. It appears desirable at this time to retain a crude system which is relatively insensitive to small variations in weather structure and which presents conservative upper limits to the fall-out hazard.

Table I — Sample Wind Forecast

Height in thousands of feet	Bearing in Degrees	Speed in Knots
2	080	08
4	080	10
6	070	10
8	090	10
10	090	08
12	110	05
14	160	05
16	200	08
18	260	13
20	230	15
25	220	18
30	210	20
35	240	23
40	250	20
45	270	28
50	270	20
55	310	15
60	350	05
65	040	10
70	090	20
80	090	30
90	090	40

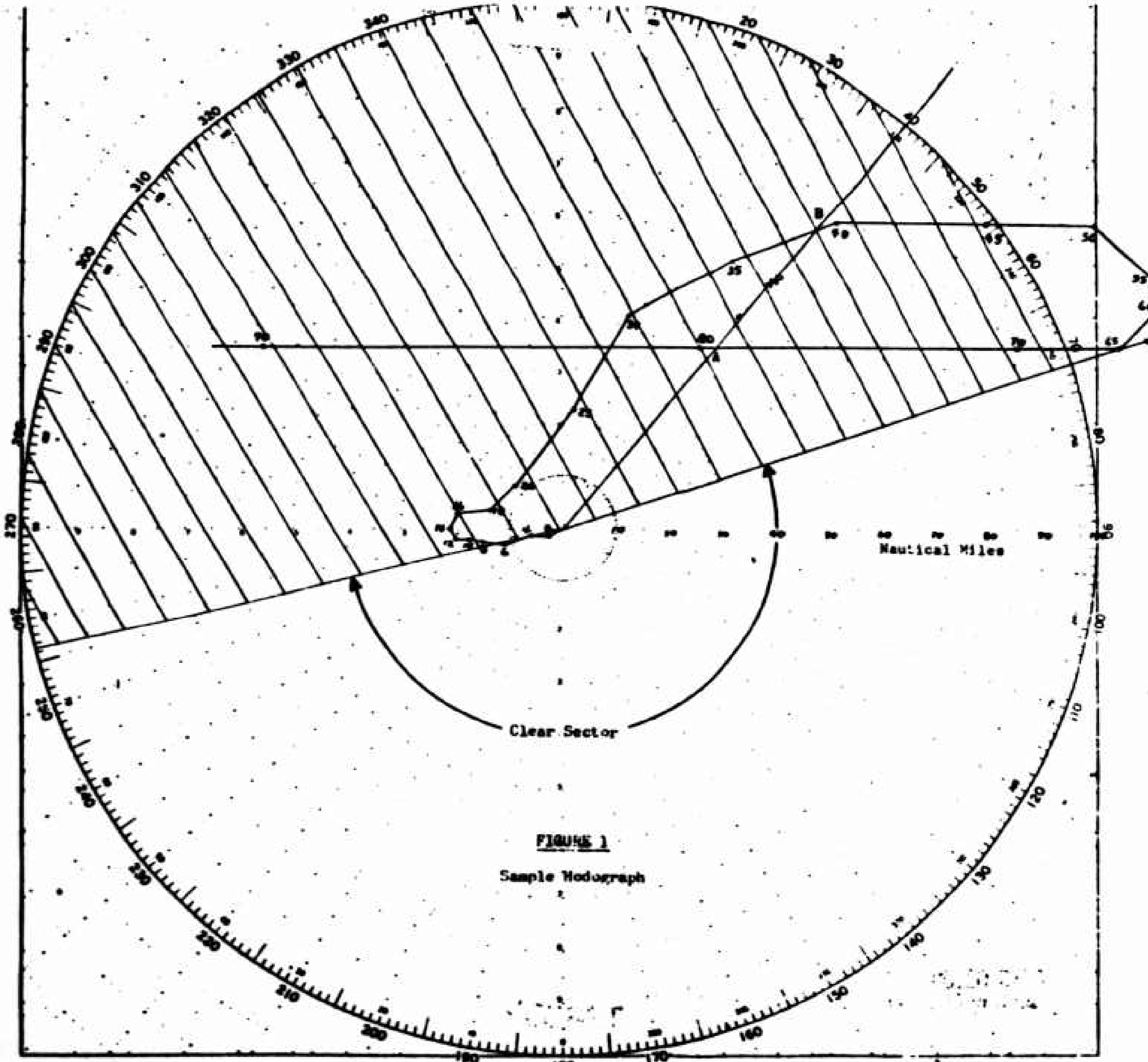

FIGURE 1

Sample Hodograph

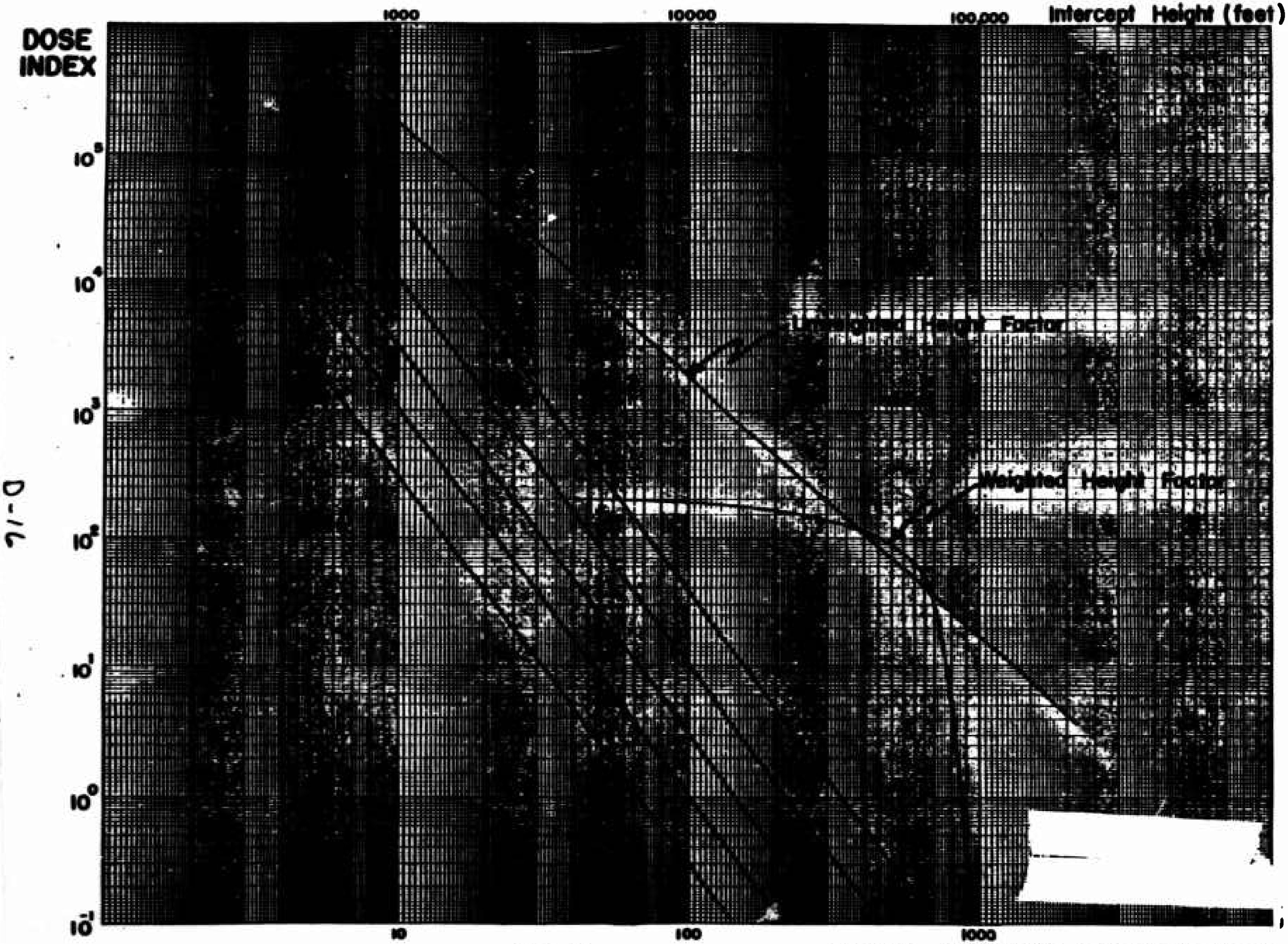

FIG 2
INDEX NOMOGRAM

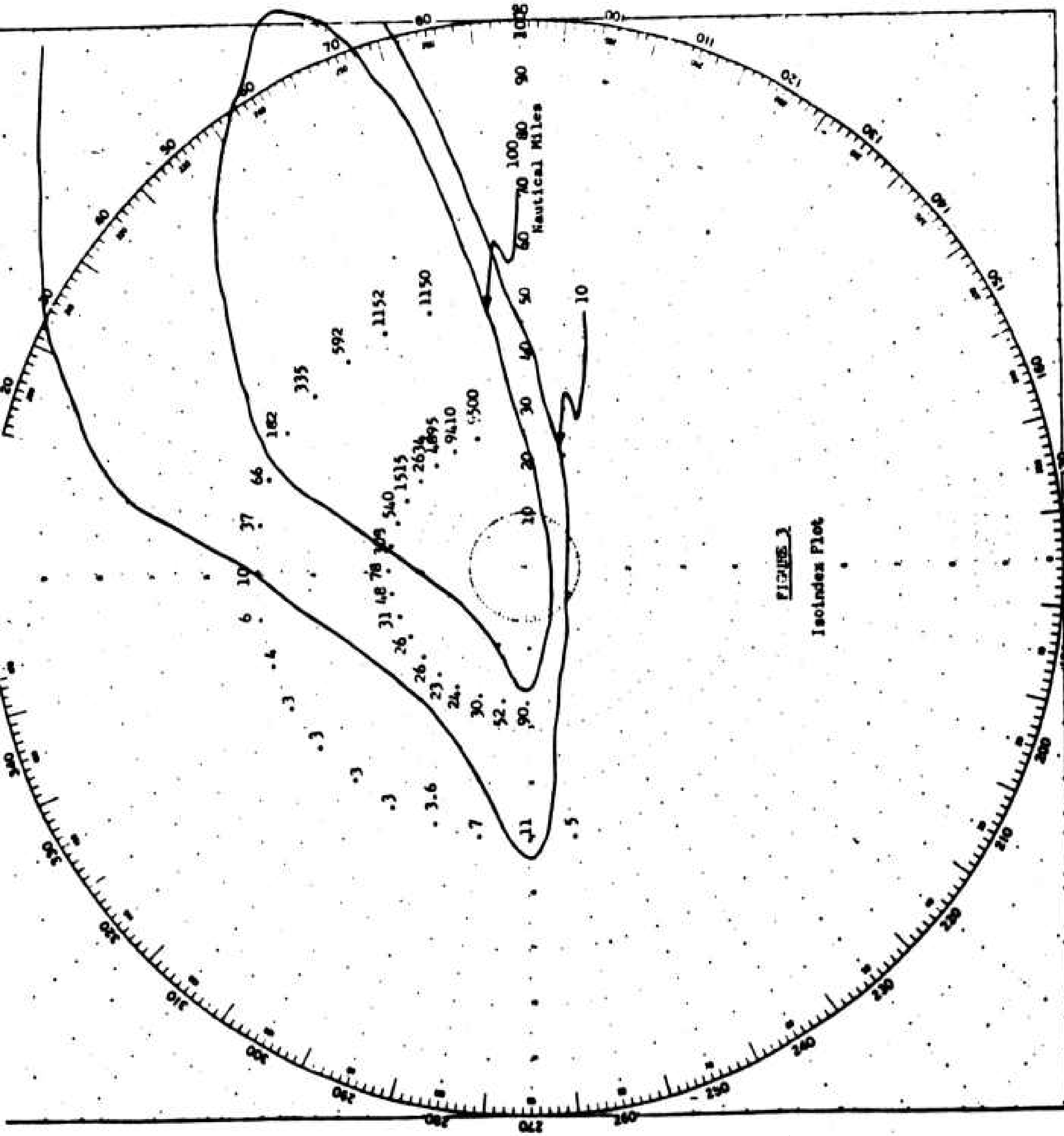

FIGURE 3
Isoindex Plot

CLOSE-IN FORECASTING BY NEW TECHNIQUES DEVELOPED AFTER BRAVO

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July 1954

1. The method of calculating local fall-out, as described here, is the hasty outgrowth of a more complex method that had been unexpectedly successful in accounting for the BRAVO fall-out pattern in the Ailinginae-Rongelap-Rongerik area. As the time of the last shot (on Eniwetok Atoll) approached, the problem of forecasting local fall-out became more acute. Since the method attempted to take account of the initial size and shape of the cloud, it seemed that it should be suitable for local forecasting. With the aid of Dr. Gaelen Felt, the method was simplified to the extent that an atoll pattern could be estimated within about an hour. The simplified method was tested against the Bikini patterns produced by ROMEO, UNION and YANKEE and found satisfactory, and the method was used in forecasting for NECTAR.

2. The following description covers the simplified method only. The more complex method warrants further study which will be reported elsewhere.

3. Assumptions:

(a) The initial cloud (after rise is practically completed) is divided into horizontal slices, each of 10,000 ft depth, with centers at 10,000, 20,000, - - - - 70,000 ft altitude, with the central concentration (radio-activity per unit volume) independent of altitude.

(b) In each layer all of the activity lies in a horizontal plane thru the center.

(c) In each layer, the concentration falls off laterally according to the law of normal distribution of errors

$$c\,(r) = C_o\, e^{\frac{-r^2}{a_o^2}}$$

where C_o is the initial central concentration, r is distance from center, and a_o is the initial spread parameter (analogous to standard deviation). For altitudes 10,000 thru 40,000 ft, a_o = 1.9 miles; 50,000 thru 70,000 ft, a_o = 5.8 miles.

INCLOSURE #3

(d) Thruout the whole cloud, all radioactive particles are of the same size, and fall at 50,000 ft per hour.

(e) In each layer, the central particle falls, without diffusion, as directed by the winds, while other particles diffuse horizontally away from the center equally in all directions so that, when the layer arrives on the surface, the distribution about the center is given by

$$c(r) = \frac{Co}{p^2} e^{-\frac{(q)^2}{(p)^2}}$$

where $p = \frac{So + S}{So}$, $q = r/a_o$, S = total horizontal distance travelled by the central particle, $So = 5.2\ a_o$. (The last quantity may be pictured as the horizontal distance back to a fictitious point source of the cloud layer).

(f) The dose rate at any point is proportional to the sum of the concentrations from all of the layers as estimated from the preceding formula.

4. Apart from the assumption of a single particle size this formulatic has a number of other obvious defects, e.g.

a. The sum of the quantities $C_o a_o^2$ should be made proportional to the total radioactive yield of the "bomb." In practice, the final estimates were adjusted somewhat on account of expected yield. This, in effect, allowed for the influence on C_o, but not on a_o.

b. The estimation of S as total horizontal distance is rather unsatisfactory in local forecasting where the atoll dimensions are not much greater than the height of the cloud.

Also, there was no time to find out whether better results could be obtained by choice of some other values for parameters such as rate of fall for the particles. From the test of the method against the Bikini patterns, it was clear that it was good enough for the purpose at hand. It appeared that differences between forecast and actual winds would be likely to produce much larger errors than those inherent in the assumptions.

5. In application, the method is not as tedious as might appear. The standard hodograph plot, giving the location of central particles falling at 5,000 ft per hour, is prepared for the Command Briefing as a matter of course. It can be superimposed on a ten times magnified atoll map, allowing for the 50,000 ft per hour fall rate assumed in the method. With a ruler of corresponding scale, the distances S, along the zig-zag path to each of the height points on the hodograph can be quickly measured or

this can be done by summation of hodograph winds if these are more readily accessible. Likewise, the distances from the altitude points on the hodograph to points of fall-out interest can be quickly measured with the ruler, giving the values of r. Knowing S and r, one can easily compute p and q. With the aid of a family of curves of $\frac{1}{p^2} e^{-\frac{(q)^2}{(p)^2}}$ vs q

(see Fig. 1) for several values of p, one can rapidly interpolate the values that must be added up at any location. The exponential factor drops off very rapidly with q, and after working out a few cases, one can tell, from an inspection of the hodograph-on-atoll plot, some of the altitude points that can be neglected in the computation.

6. Fig. 2 and Table 1 illustrates the application of the method to NECTAR shot, using the winds observed at shot time. The points on Fig. 2 marked 10, 20, 30, are the 10,000 ft, 20,000 ft, - - - altitude points on the hodograph for particles falling 50,000 ft per hour. A particle starting, for example, at 30,000 ft above ground zero, and falling under the influence of winds but not diffusion, would land at the point marked 30. The value of S, the horizontal distance travelled, is estimated by summing the distance between the successive points from ground zero to point 30. In calculating q in Table 1, some values are omitted as beyond the range of Fig. 1. More values are dropped, as too small to bother with, in entering the quantities $\frac{1}{p^2} e^{-\frac{(q)^2}{(p)^2}}$. The final totals are the surface concentrations that would be produced if the initial central concentrations (C_0) were all unity. When the method was tried out on YANKEE, it was found that if the resultant surface concentrations were multiplied by 100, they agree reasonably well with the dose rate, in roentgens per hour, measured one day after the shot. This factor was used in making up Table 2, and it appears to give fairly good results for BRAVO, ROMEO, and UNION also, although there is some tendency to over-estimate the lower dose rates at the larger distances. In Table 1, however, it is clear that the agreement is about as good as in Table 2 <u>without multiplying by a factor of 100</u>. The yield of NECTAR was less than that of the shots in Table 2, but not by a factor of 100. At the present time the only explanation that can be offered for this discrepancy is the heavy rain that occurred on NECTAR day.

7. There is good reason to anticipate that the current detailed study of the more complex method will yield a better simplified technique than the above. For this reason, there is little justification for a more elaborate report on the method at this time.

TABLE 1

HEIGHT (1000 FT)	a_o (MI)	So (5.2 a_o)	S (MI)	p (So/S) (So)	$q = r/a_o$ ALICE	JANET	SALLY	ELMER
70	5.8	30	29	2.0	1.6	1.4	2.3	4.4
60	5.8	30	23	1.8	2.2	1.5	1.7	4.1
50	5.8	30	19	1.6	2.1	1.3	2.1	4.5
40	1.9	10	12	2.2	4.5	4.7	—	—
30	1.9	10	9	1.9	3.1	4.2	6.8	—
20	1.9	10	6	1.6	2.4	4.4	—	—
10	1.9	10	3	1.3	1.2	3.0	5.6	—

$$\frac{1}{p^2} \; e^{-\frac{(q)^2}{(p)^2}}$$

HEIGHT	p	ALICE	JANET	SALLY	ELMER
70	2.0	.14	.16	.07	.0020
60	1.8	.07	.15	.12	.0020
50	1.6	.07	.20	.07	—
40	2.2	—	—	—	—
30	1.9	.02	—	—	—
20	1.6	.04	—	—	—
10	1.3	.23	—	—	—
	TOTAL	.57	.51	.26	.002
OBSERVED R/HR at N+1 DAY		.70	.18	.027	.000

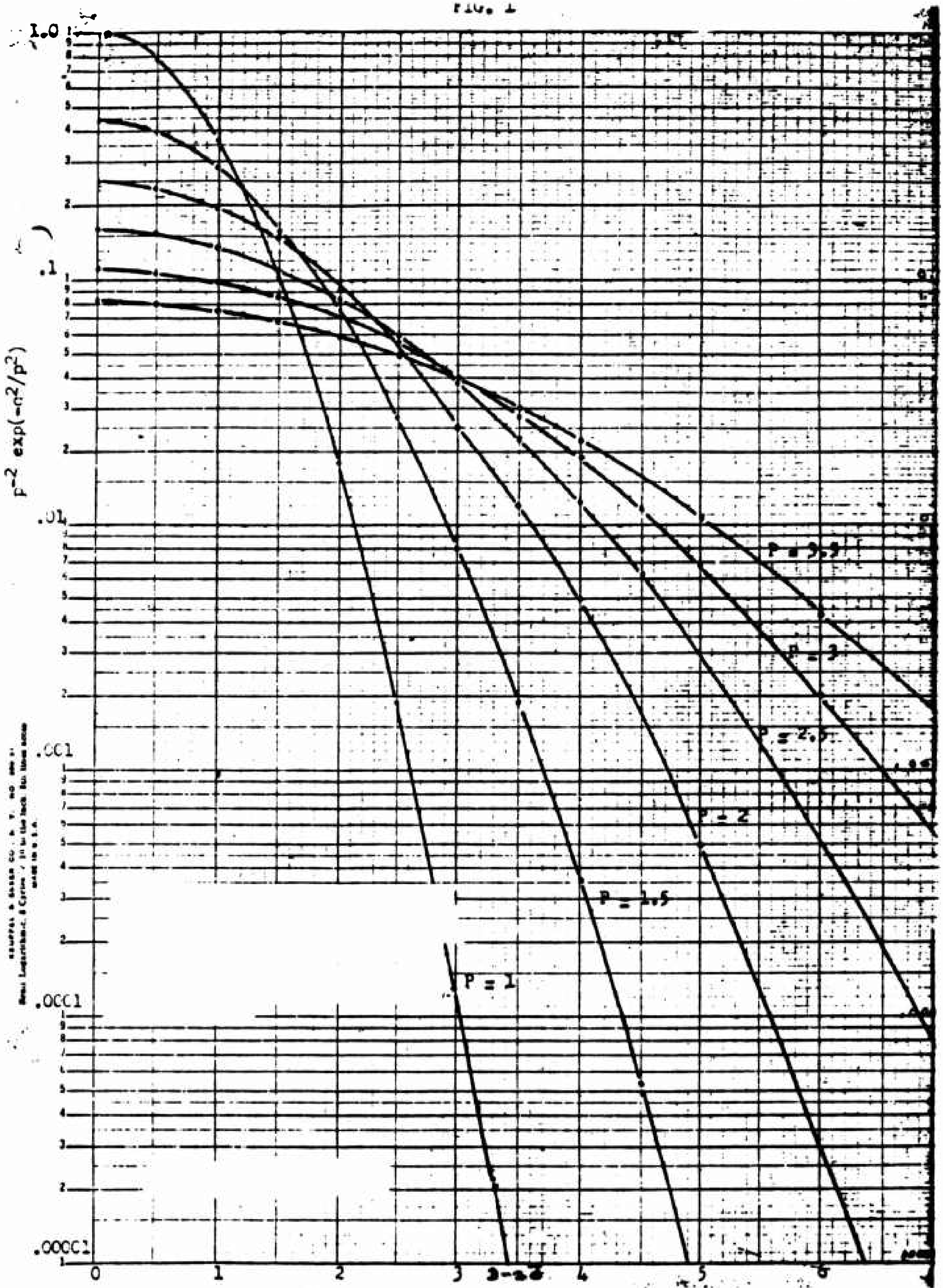
TABLE 2

BIKINI R/HR AT D + 1 DAY

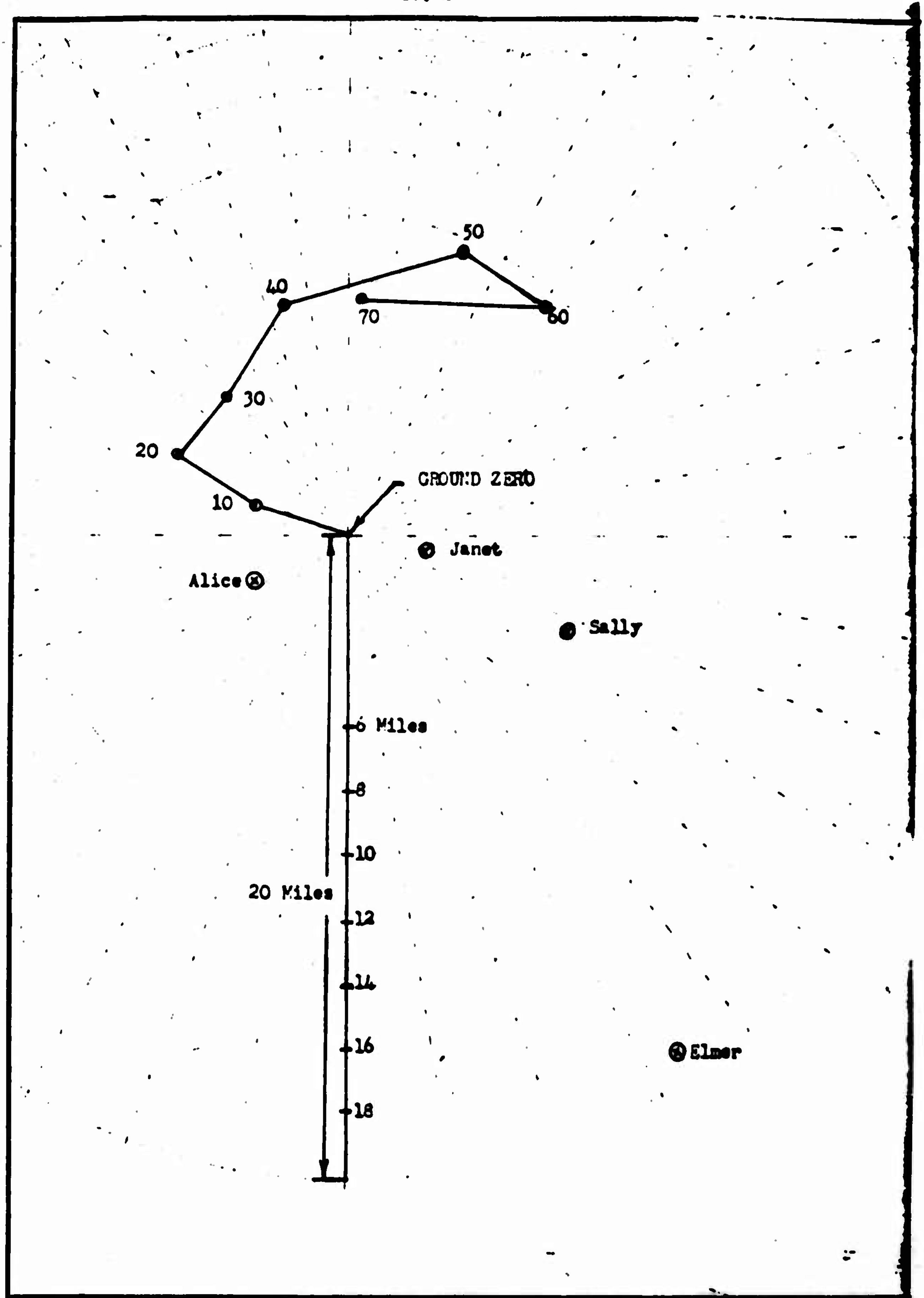
ISLAND	BRAVO		ROMEO		UNION		YANKEE	
	OBS	CALC	OBS	CALC	OBS	CALC	OBS	CALC
HOW	24	22	0	0.6	8.5	9	25	30
NAN	9	5	0	0.6	0.09	2	2	7
OBOE			0	0.6	0	0.7	0.04	3
UNCLE	1.0	0.9					0	5
BRAVO	1.0	0.6					0.5	0.3
ABLE			50	70			2	5
FOX	55	47			12	45		

100

FIG. 1



1.0
.1
.01
.001
.0001
.00001
$p^{-2}\exp(-\alpha^2/p^2)$
0
1
2
3
4
5
6
P = 3.5
P = 3
P = 2.5
P = 2
P = 1.5
P = 1


50
40
70
60
30
20
10
GROUND ZERO
Janet
Alice
Sally
6 Miles
8
10
20 Miles
12
14
16
18
Elmer

TAB "E"

CLOUD TRACKING PLAN

6 Incls:
1. Details for WB-29 Cloud Tracking Flights
2. WB-29 Cloud Tracking Flight #1
3. WB-29 Cloud Tracking Flight #2
4. WB-29 Radsafe Code
5. Details for Radiation Reporting by all Aircraft (Except the Cloud Sampling Team) Operating Between Eniwetok and Bikini Between H-Hour and H plus 24 hours.
6. Sequence Cloud Report for Control B-36 Sampling Operations with 1 Appendix.

CLOUD TRACKING PLAN

1. JTF SEVEN Operation Order No. 3-53 indicated in general terms the radsafe aerial survey responsibilities assigned to TG 7.4. These were as follows:

a. Provide cloud tracking aircraft for post-shot radiological safety situation data up to a radius of 500 miles in the significant quadrant for a period of 48 hours, starting at approximately H plus 6 hours (Note: Later changed to start at H hour).

b. During the Bikini phase provide for air-to-ground reporting of approximate radiation (air) intensities encountered by all aircraft operating between Eniwetok and Bikini from H hour to H plus 24 hours.

2. The three general types of aerial survey coverage were:

a. Special WB-29 missions were scheduled specifically for cloud tracking purposes using in-flight air-to-ground reporting procedures. These missions started at H hour and ran for 48 hours, with a requirement for a maximum of one aircraft to be on station at any one time. Flights #1 and #3 as defined in Incl 1 also satisfied the requirement for one of the two weather reconnaissance flights required on each day of the period involved. Normal weather reconnaissance meteorological reports were required on all cloud tracking flights performed with WB-29 equipment. In a similar manner it was required that all WB-29 flights scheduled during the 48-hour period for specific weather reconnaissance missions include reports on radiation encountered.

b. In-flight air-to-ground reports were required from all aircraft (other than the cloud sampling team) operating between Eniwetok and Bikini from H to H plus 24 hours on other than specific radsafe missions. The requirement was designed to use existing aircraft operational schedules and was not to involve scheduling of aircraft for the radsafe mission alone. (Incl 5)

c. Radio interception of sequence reports from and between the cloud sampling aircraft, control aircraft and the Air Operation Center was made at the Radsafe OFFICE from H to H plus 6 hours. (Incl 6)

3. The cloud tracking plan was designed around a consideration of economical use of the available aircraft to survey only the critical areas rather than to follow the drift of all segments of the cloud. The primary consideration leading to a requirement for cloud tracking was the safety of task force elements, contiguous populated areas and the users of the air and surface routes in the general area.

a. It was considered that the areas of most concern, in sequence of priority interest were as follows:

(1) The downwind (trade wind) region from ground zero (GZ). This area included both the task force camp at Eniwetok and the native populated atoll of Ujelang. It was considered first priority due to the fact that the development of potentially hazardous conditions off-site would, from the viewpoint of fall-out rate and time of arrival, be first detectable in this general area. Consequently, it was planned that the tracking efforts should first be devoted to a patrol to the west of GZ in such a way that the task force camp at Eniwetok and Ujelang Atoll would be placed in the "shadow" of the search aircraft. This was accomplished by setting up a racetrack holding pattern to patrol generally north and south across a sector limited by bearings from GZ to Eniwetok and Ujelang, with sufficient additional spread on the sector to assure complete coverage of any contaminated air likely to drift to these two locations (Flight #1. See Incl 2). Since conditions developing during the first hour or two after shot time were assumed insufficiently stable to warrant a detailed analysis and too close-in for reasonable safety of the aircraft crew, Flight #1 was designated to begin its patrol at about H plus 2 hours and 50 miles west of GZ. Ten thousand feet was the altitude selected as the most reasonable compromise for the data desired. It was assumed that a patrol of about 3 hours should be sufficient to obtain the answers needed, however, the plan provided for a longer period of patrol if specific shot circumstances required such a modification. On several shots this action was necessary.

(2) The upwind (trade wind) region from GZ. This was the region from which secondary fall-out could occur on the task force shot-atoll camp site and fleet. Since fall-out from this region would arise from the settling of contamination into the trade winds from higher levels (which had transported debris to the east), a consideration of fall rate and time of arrival dictated patrol of this region later than 3a (1) above but within about 6 to 12 hours post-shot. An "E" type search pattern at 10,000 feet was specified for the aircraft described in 3a (1) above, to be flown following the racetrack holding mission (Flight #1).

(3) The upwind (trade wind) region from the native populated atolls in the southeast quadrant. This area was of concern for the same reason as 3a (2) above, but considered of less urgency on shot day due to its more favorable location with respect to GZ and due to the greater distances from GZ and the longer period of time required for detectable contamination to reach geographical positions potentially hazardous to those atolls. An "E" type search pattern was designated to be flown at 10,000 feet (Flight #2. See Incl 3).

(4) Air and surface routes through Wake and the Marshall Islands. These areas were considered of least priority due to separate advance action taken to close and sweep the forecast questionable sectors and routes. The last half of Flight #2 was selected for this requirement to be flown at 10,000 feet and through the region north of GZ determined to be representative from the forecast air radex and the air particle trajectories.

(5) Two additional aircraft (Flights #3 and #4) were planne to search from H plus 24 to H plus 36 hours and from H plus 36 to H plus

48 hours. The flight tracks of these patrols were to be determined after the shot and based upon the results and circumstances of the first 24-hour period and the forecast and observed meteorological conditions. A further augmentation of the over-all cloud tracking effort was planned to come from periodic radiation reports from aircraft on primary missions of weather reconnaissance out to approximately 1,000 miles from H to H plus 48 hours.

b. Although the prime cloud tracking effort immediately post-shot was planned as indicated in 3a above, certain other initial actions to assess development of the long-range fall-out potential of the shot were also taken at this time. It was planned to intercept the reports of the cloud sampling team to determine heights, initial drift and intensities of all segments of the cloud from about H to H plus 6 hours (Incl 6). Further, it was planned that all operational aircraft other than the cloud sampling team would report any encounter with radiation while engaged in their assigned flight missions (Incl 5). Since the latter group of aircraft, as a rule, were attempting to avoid contamination information from that source was basically "negative" and served primarily to define "clean" areas. The totality of all information gathered during the early post-shot phase, together with the wind observations and forecasts, was assumed to be sufficient to present a reasonably clear indication of future developments of the cloud, and in sufficient time to verify decisions relative to safety of personnel in the shot area.

c. Although no specific patrol was designed to search air and surface routes through the Marshalls, the relatively favorable positions of these areas, coupled with wind forecasts and observations, advance action to close routes if necessary, "bonus" results from the efforts described in 3a and b above, and the presence of fixed land monitor stations at several points in the area, were considered sufficient to formulate decisions relative to the hazard potential for such routes.

6 Incls:
1. Details for WB-29 Cloud Tracking Flights
2. WB-29 Cloud Tracking Flight #1
3. WB-29 Cloud Tracking Flight #2
4. WB-29 Radsafe Code
5. Details for Radiation Reporting by all Aircraft (Except the Cloud Sampling Team) Operating Between Eniwetok and Bikini Between H Hour and H plus 24 Hours.
6. Sequence Cloud Report for Control B-36 Sampling Operations with 1 Appendix

DETAILS FOR WB-29 CLOUD TRACKING FLIGHTS

1. Shot Participation: All shots.

2. Duration: 48-hour coverage starting at H hour with a requirement for a maximum of one aircraft to be on station at any one time.

3. Flight Plans: Four twelve-hour periods are designated Flights #1 through #4 as follows:

a. Flight #1 (H to H plus 12 hours). This flight is to determine in sequence the characteristics of the radiological hazard likely to drift and fall out on Eniwetok or Ujelang Atolls and the hazard upwind from the shot atoll. The first portion of the flight will consist essentially of a 10,000-foot racetrack holding pattern of approximately five hours duration and extending 70 nautical miles from north to south. The H hour position of the eastern edge of the pattern will be at 50 nautical miles west of ground zero. Upon encountering radiation, the entire pattern is to be shifted westward to follow the leading edge of the radiation field. The search upwind from the shot atoll will be made in a 30 degree sector with apex on ground zero and centered on the average prevailing easterlies. "E" type search pattern at 10,000 feet will be employed. Specific instructions for this mission will be forwarded by CJTF SEVEN to CTG 7.4, ATTN: Commander, Test Services Unit, not later than H minus 8 hours.

b. Flight #2 (H plus 12 hours to H plus 24 hours). This flight is to determine the characteristics of the radiological hazard existing upwind from the native populated atolls in the southeast quadrant and the hazards existing on, or near, air routes of interest to commands external to the task force area of responsibility. Upwind for the native populated atolls is defined as a 30 degree sector (as in Flight #1) with apex on Rongerik Atoll. "E" type search pattern at 10,000 feet will be employed. Search of air routes is to be at 10,000 feet and along the routes, or through the area forecast to be upwind from such routes, for a representative distance determined by the estimated limits of accuracy of the Air RADEX. The attempt here will be to determine the contamination status of the air on the routes or the potential hazards likely to drift across the routes. The air routes of interest are those through Wake and the Marshall Islands. Specific instructions will be forwarded by CJTF SEVEN to CTG 7.4, ATTN: Commander, Test Services Unit, not later than H plus 4 hours.

c. Flight #3 (H plus 24 to H plus 36 hours). This flight will attempt to determine the extent and drift of other major segments of the atomic cloud as practicable and as required by existing meteorological influences. Areas and altitude of search are to be specified later and will be contingent upon the above influences and the results of Flights #1 and #2. Flight #3 will be planned and executed by the operating agency upon directive (issued not later than take-off minus 8 hours) from CJTF SEVEN, as for Flights #1 and #2. It is expected that this directive will indicate a vectored mission. The necessity for scheduling this flight will be determined by CJTF SEVEN on the basis of the results of Flights #1 and #2 and other sources of information.

d. Flight #4 (H plus 36 to H plus 48 hours). The necessity for scheduling this flight will be determined by CJTF SEVEN on the basis of the results of Flights #1, #2, #3 and other sources of information.

e. Other Flights: WB-29 flights scheduled at any time during the 48-hour period for specific weather reconnaissance missions will make routine reports on radiation encountered.

4. Mission Directives: Mission directives from CJTF SEVEN will be routed through normal command and communications channels. However, to insure that advance details get to the operating agency sufficiently in advance of the missions, an informal mission directive will be transmitted directly to the WB-29 squadron through "Weather Central-Weather Station" RATT channels by Mission Take-off time minus 8 hours for each flight.

5. Data to be Obtained: The basic requirement for these flights is to establish a file of data of sufficient accuracy to support conclusions and decisions relating to health hazards and means of avoidance and to confirm or modify forecast cloud segment drift. The data will also be used to advise specified agencies having interests contiguous to the task force area of responsibility. In general, the missions are to be flown on the tracks specified with maximum emphasis on complete coverage of the designated areas. It is not anticipated that in-flight analysis of the over-all situation is necessary except that tracking aircraft crews should recognize cloud boundries and leading edges. Normally, penetration of the highly contaminated areas will not be necessary or required unless specifically directed under unusual circumstances. Deviations from the prescribed track and reporting positions should be made only upon entry into highly contaminated areas. For cloud tracking missions, turn-out will be executed at intensities of not more than 3.0 r/hr. Following such turn-out, appropriate in-flight adjustment of track should be made by the aircraft commander in the interest of maximum coverage of the designated area. The Radsafe monitor is to exercise discretion on turn-out from highly contaminated areas and to consider crew personnel dosages and and anticipated duration of flight through the radiation field. The limit of 3.0 r/hr is specified as a maximum rather than a limit to which penetration must be made.

6. RADIAC Equipment: Since highly precise measurements are not required, suitable RADIAC equipment and reporting codes are specified accordingly. Each flight will have on board sufficient instruments of the following type to insure reasonable expectancy of proper functioning of at least one of each type:

a. AN/PDR-T1B

b. MX-5 or any equivalent military instrument such as the AN/PDR-27, capable of direct reading in milliroentgens per hour.

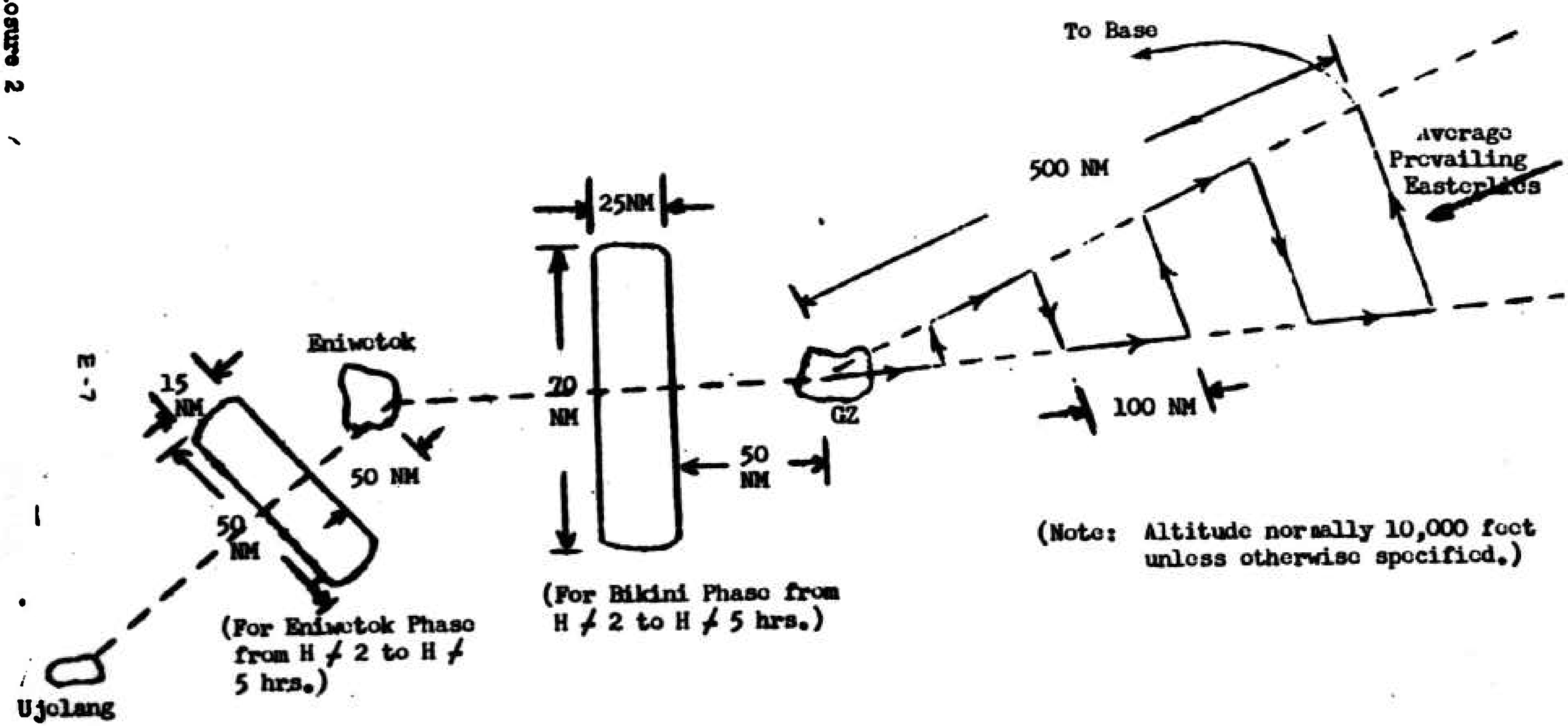
c. An additional survey instrument of the scintillation counter type will be made available to the task force on a loan basis. This instrument appears promising, and will be furnished to the WB-29 operational personnel for additional RADIAC back-up.

7. In-Flight Reports: In-flight reports on radiation will be made in conjunction with the half-hourly standard weather reporting messages used for weather reconnaissance flights. (See Incl 4 of Tab E for radiation reporting code.) Special reports are to be transmitted for any positions where radiation intensity reaches a maximum along a segment of the flight track regardless of whether or not such positions coincide with points of regular half-hourly weather reports. Additional special reports should be made at any critical position in the flight track such as positions which define a cloud boundary, a turn-out point, or any unusual situation.

8. Post-flight Reports: Post-flight reports will not be required by CJTF SEVEN unless, in the judgment of any of the personnel involved, one-time reports are considered necessary for clarity or for improving the cloud tracking operation. Flight Radsafe logs maintained by WB-29 crews will be forwarded to CJTF SEVEN post-shot.

9. Routing of Radiation Reports: Reports will be routed as normal weather reconnaissance reports to the Weather Central. The Weather Central will relay the reports to the RADSAFE OFFICE.

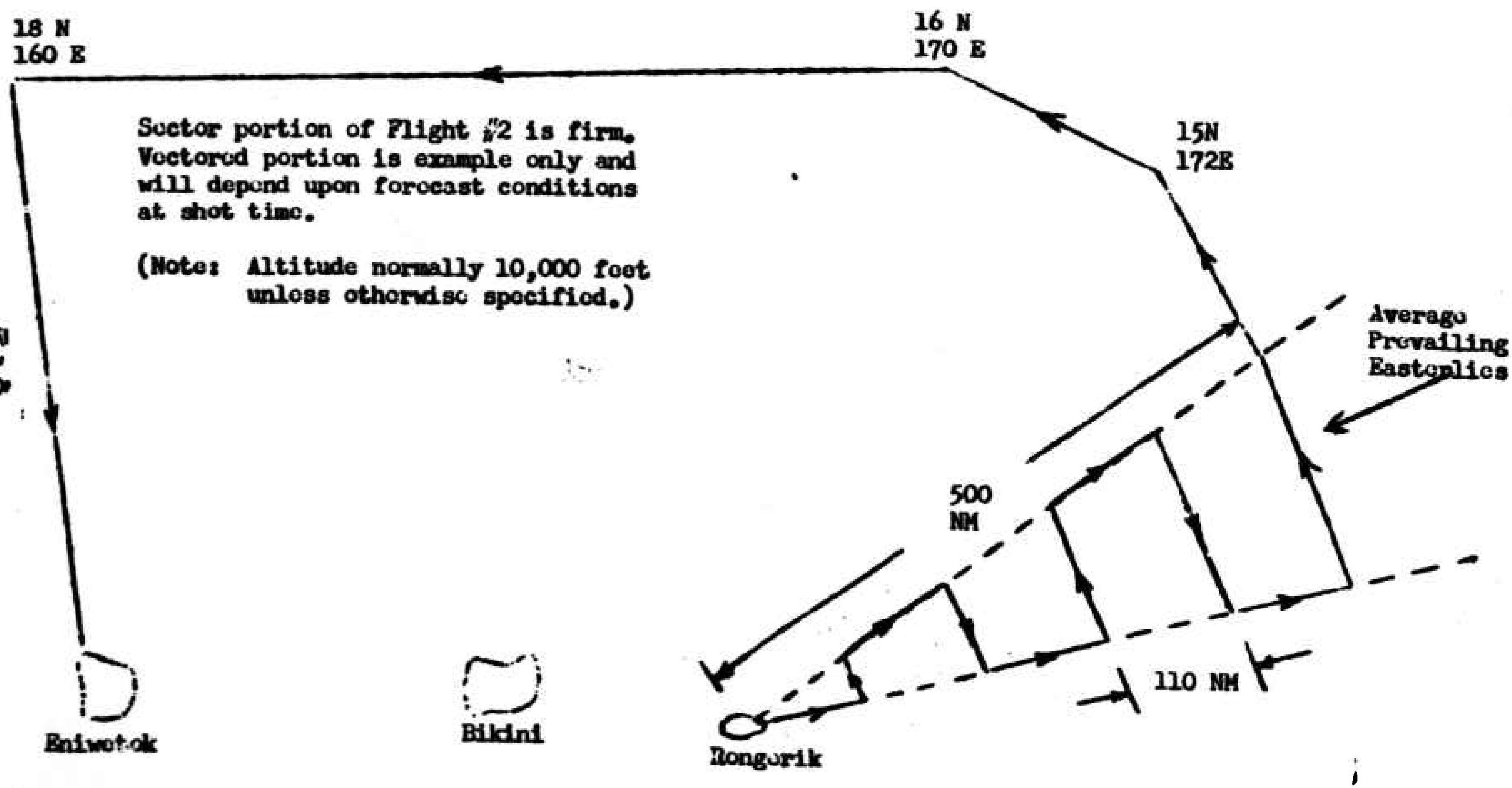
FLIGHT #1, WB-29 SECTOR SEARCH MISSION FOR CLOUD TRACKING



E-7

Inclosure 2

FLIGHT #2, WB-29 SECTOR AND VECTOR SEARCH FOR CLOUD TRACKING



Sector portion of Flight #2 is firm. Vectored portion is example only and will depend upon forecast conditions at shot time.

(Note: Altitude normally 10,000 feet unless otherwise specified.)

WB-29 RADSAFE CODE

1. The code for in-flight reporting of radiation will be used in conjunction with the five-digit groups normally devoted to AFOAT-1 reporting. Position, time and altitude will be as normally reported on weather reconnaissance flights. The first group of the five-digit AFOAT-1 groups will be used to encode the radiation observations. Readings and general observations are to be coded in sequence and in conformance with the code below. Should the first five-digit group not adequately describe the report, successive five-digit groups should be used. To indicate such amplification, the first digit of the first five-digit group should be coded accordingly. The numbers indicated for coding the desired information below are examples only. Formal random code numbers will be assigned by CJTF SEVEN prior to each shot for successive three-hour periods starting at H hour and terminating at H plus 48 hours. Copies of formal code numbers will be furnished to the Weather Central and the operating agency.

CODED NUMBERS FOR PERIODS IN HOURS AFTER H HOUR				RADIATION INFORMATION
H hr to 3	3 to 6	6 to 9	9 to 12	First Digit (Report identification)
4	6	1	7	No detectable radiation above background.
9	2	6	8	Radiation (gamma only) report follows.
7	0	4	2	Radiation (gamma only) report follows with one amplifying five-digit group.
8	4	7	1	Radiation (gamma only) report follows with two amplifying five-digit groups.
3	9	8	6	Radiation (gamma only) report follows with three amplifying five-digit groups.
1	5	3	0	Dummy.
5	1	9	3	Dummy.
6	8	0	5	Dummy.
2	3	5	9	Dummy.
0	7	2	4	Dummy.
				Second Digit (Intensity reading above estimated aircraft background)
2	6	5	3	Less than 10 mr/hr, but above background.
7	2	8	6	10 to 50 mr/hr.

Second Digit (continued)

5	7	2	0	50 to 100 mr/hr
3	4	0	8	100 to 500 mr/hr
9	1	3	2	500 to 1000 mr/hr
6	5	9	1	1 to 5 r/hr
8	9	1	5	5 to 10 r/hr
1	8	6	4	More than 10 r/hr
4	0	7	9	Dummy
0	3	4	7	Dummy
				Third Digit (Pertinent additional information on readings reported)
8	9	2	6	No comment on reported readings, or this is an amplifying five-digit group.
5	7	0	3	Instruments (RADIAC) malfunctioning
2	5	1	9	Readings fluctuating
6	2	3	5	Spotty radiation levels encountered.
0	3	5	2	Radiation levels in the area are higher but flying on fringe and taking observations at lower radiation levels.
3	4	7	0	Having passed through rain shower, background is definitely higher.
1	6	4	8	Readings fluctuating because of intermittent showers.
4	0	6	1	Radiation intensity approximately constant since last report.
7	8	9	4	Radiation intensity steadily increasing since last report.
9	1	8	7	Radiation intensity steadily decreasing since last report.
				Fourth Digit (General trends of mission and other pertinent information)
5	7	2	4	Radsafe mission progressing satisfactorily.

Inclosure 4

Fourth Digit (continued)

1	4	5	2	Changed track (for Radsafe reasons) to that indicated in the clear at end of this message, (Indicate track change in approximate full degrees of latitude and longitude from present position.)
2	1	3	0	Having mechanical difficulties which affect Radsafe mission or designated track. (Amplify at end of message, in the clear, if desired.)
3	0	4	9	Cloud is visible.
6	2	0	3	Cloud is not visible.
0	5	6	7	No comment.
4	9	8	5	Dummy.
7	3	9	8	Dummy.
9	8	1	6	Dummy.
8	6	7	1	Dummy.

Fifth Digit (For amplification of previous information)

2	5	7	1	No comment.
4	2	0	3	Executed turn-out at intensity indicated in second digit of this report.
1	9	4	2	Operating position relative to cloud is unknown.
7	1	9	0	Working leading edge of cloud.
9	6	5	4	Working cloud boundary.
0	8	6	5	Dummy.
3	4	8	6	Dummy.
5	7	2	9	Dummy.
6	0	3	8	Dummy.
8	3	1	7	Dummy.

EXAMPLE: (H plus 8-hour message)

"...........40549 34126 64321 83679..........."

"Radiation report follows with one amplifying five-digit group."

100 to 500 mr/hr, radiation levels in the area are higher but flying on fringe and taking observations at lower radiation levels, cloud is visible, working leading edge of cloud, dummy, dummy, readings fluctuating, Radsafe mission progressing satisfactorily, dummy, plus two dummy five-digit groups."

2. Post BRAVO modification of above:

a. Reference paragraph 1 above, and in order to report actual values of the intensity reading instead of the block-values given by the second digit, a change was made whereby the successive digits of the first available dummy five digit group was used to indicate the specific value of the reading within the block-value given. Thus, if the block-value were 500 - 1000 mr/hr, followed by the group 75022, the true reading would be 750 mr/hr. This change also made use of the last digit of the group to indicate the type of instrument used, i.e., 1 for AN/PDR-T1B and 2 for Scintameter. 75022 therefore would completely designate a reading of 750 mr/hr by scintameter.

b. Reference paragraph 1 above, the second digit was designed to indicate intensity readings above estimated background. This was changed to indicate gross readings in order that the true intensity of exposure on the aircraft crew could be assessed. In the interest of flexibility in the reporting procedure provision was made for the aircraft crew to report estimated aircraft background by using the first digit to indicate "no detectable radiation above background," the second digit to indicate the block-value of the estimated background reading and the successive digits of the next five digit group to indicate the actual intensity reading in mr/hr in accordance with paragraph 2a above.

DETAILS FOR RADIATION REPORTING FOR ALL AIRCRAFT (EXCEPT THE CLOUD SAMPLING TEAM) OPERATING BETWEEN ENIWETOK AND BIKINI BETWEEN H HOUR AND H PLUS 24 HOURS

1. Shot Participation: All shots.

2. Duration: 24-hour coverage starting at H hour.

3. Designation of Flights: There is no requirement for special flights solely for this requirement. The assumption here is that wherever practicable, aircraft scheduled to be in the region between Eniwetok and Bikini Atolls will be equipped to measure and report ratiation encountered.

4. Data to be Obtained: The basic requirement for these flights is to establish a file of data of sufficient accuracy to support conclusions relating to health hazards likely to drift and fall out on Eniwetok and Ujelang Atoll, and to support decisions relative to the necessity for evacuation. Since highly precise measurements are not required, suitable RADIAC equipment and reporting codes are specified below accordingly. It is intended that, where practicable, aircraft crews encountering radiation attempt to determine the approximate size of the affected area and the position of the leading edge of the cloud. This information is basic in determining the probably fall-out effect on Ujelang and the Eniwetok Atoll Camp site.

5. RADIAC Equipment:-

a. Each multi-engine aircraft should have on board instruments of the following type to insure reasonable expectancy of proper functioning of at least one instrument:

(1) AN/PDR T1B or similar type.

(2) MX-5 or any equivalent military type instrument, such as the AN/PDR-27, capable of direct reading in milliroentgens per hour.

b. All readings should be gamma only and the intensity observed in excess of estimated aircraft background.

6. Radsafe Monitors on Aircraft: The operating agency monitors required for multi-engine aircraft crews, are to be used for this requirement. These monitors will be responsible for determining the frequency of and the making of radiation measurements, coding the information and insuring that the information is placed in the air-to-ground communication system.

7. Codes: The following code for reporting radiation has been designed primarily for voice air-to-ground transmission. It is intended that, where necessary and if feasible, reports by CW are also to be used. In the event distance is a factor and only voice transmission equipment is available, delayed reports are to be made when the aircraft is within voice range of either the Eniwetok AOC or the Bikini AOC as applicable. The report should be formulated and reported in the following sequence:

a. Aircraft Call Sign.

b. The report will be identified as a "Sweet-sour Report".

c. Approximate local time, position and altitude of aircraft will be given in the clear.

d. Code for radiation intensity reading (above estimated aircraft background). (Code numbers will be re-designated by CJTF SEVEN for each shot. The numbers indicated below are for example only).

55 No detectable radiation above background.

77 Less than 10 mr/hr, but above background.

33 10 to 50 mr/hr.

66 50 to 100 mr/hr.

11 100 to 500 mr/hr.

99 500 to 1000 mr/hr.

22 1 to 5 r/hr.

00 5 to 10 r/hr.

88 More than 10 r/hr.
44 Dummy.

e. The contaminated area is to be designated as "GILDA". The size of the area is to be designated in approximate nautical miles in the north-south direction followed by the approximate nautical miles in the east-west direction, i.e. "50 slash 20". The approximate center of the contaminated area should be given by nautical miles in relation to a fix. If the area is unknown, transmit "GILDA Negative". The leading edge of the cloud is to be designated GILDA ABLE and located in nautical miles in relation to a fix; if unknown, transmit "GILDA ABLE Negative". If the contaminated area has been completely defined above it will be assumed that the leading edge is also defined concurrently.

f. EXAMPLE:

"This is SAND BLASTER TWO/ Swee-sour Report/ one six three zero/ four zero west of (fix)/ ten thousand/ one one/ GILDA six zero slash four zero slash five zero northwest of (fix)/ GILDA ABLE six zero west of (fix)."

for

"SAND BLASTER TWO radiation report, 1630 local, 40 NM west of (fix), 10,000 feet, 100 to 500 mr/hr, area of cloud 60 NM north-south by 40 NM east-west, centered at 50 NM northwest of (fix), leading edge is at 60 NM west of (fix)."

8. Special Reports:

a. Occasional negative reports should be made during periods of comparatively light communications load. These could be added to other routine reports, such as "......Sweet-sour negative". Such reports not only assure proper functioning of the reporting system, but also serve to positively identify non-contaminated areas.

b. Post-flight reports will not be required by CJTF SEVEN unless in the judgment of any of the personnel involved, one-time type reports are considered necessary for clarity or for improving the Radsafe operation.

9. Routing of Reports: Expeditious relay of the in-flight reports to the RADSAFE OFFICE at the Command Post of CJTF SEVEN is essential. Consequently, voice contacts with the AOC aboard the Command Ship (or through the "Eniwetok AOC-Hot Line) are preferred. All reports should contain instructions in ghe message for expeditious relay to the RADSAFE OFFICE.

Sequence Cloud Report for Control B-36 Sampling Operations
(GILDA REPORT CODE)

1. This sequence report has been designed to provide information on the initial break up and radiation intensities in the cloud during the period H to H plus 6 hours. Information to be reported includes approximations of the altitudes of tops of each of the major clouds segments and an estimate of successive positions and diameters of these segments. Further, pertinent information will be obtained on penetrations by sampling aircraft. This latter information will be directly intercepted by the JTF SEVEN RADSAFE OFFICE on sampling aircraft VHF Easy channel reports to the Control B-36.

2. The report will be formulated by the scientific director in the Control B-36 and reported in the following sequence:

ITEM	INFORMATION	REPORT (Example)
A	Local time of reported conditions	0800
B	Number of major cloud segments	4
C	Top of first (highest) segment (Est Alt in thousands)	100
D	Top of second segment (Est Alt in thousands)	60
E	Top of third segment (Est Alt in thousands)	30
F	Top of fourth segment (Est Alt in thousands)	20
G	Top of fifth segment (Est in Alt in thousands)	Negative
H	Estimated position and extent of first (Highest) segment (in NM with respect to GZ, in degrees from GZ and diameter in NM)	80 by 90 by 40
I	Estimated position and extent of second segment (in NM with respect to GZ, in degrees from GZ and diameter in NM)	75 by 45 by 30
J	Estimated position and extent of third segment (in NM with respect to GZ, in degrees from GZ and diameter in NM)	50 by 00 by 40

K Estimated position and extent of fourth segment (in NM with respect to GZ, in degrees from GZ and diameter in NM) 40 by 250 by 30

L Estimated position and extent of fifth segment (in NM with respect to GZ, in degrees from GZ and diameter in NM) Negative

3. Reports should be made as often as is feasible under operational conditions. If necessary, the report may be followed by a verbal description to clarify essential features of the cloud.

EXAMPLE: "This is _____/GILDA REPORT/0800/4/100/60/30/20/Negative/80 by 90 by 40/75 by 45 by 30/50 by 00 by 40/40 by 250 by 30/Negative/verbal description if necessary/Over".

4. The attached format will be used for intercept (on VHF Easy channel) of sampling aircraft penetrating information. Intercepts will be made on F84, B-36 Featherweight and Heavy Nuclide Sampler reports to the Control B-36.

Appendix:

I - Sampling Aircraft Penetrating Report

SAMPLING AIRCRAFT PENETRATING REPORT

Shot # ____________________ Date ____________________

A/C # ____________________

Pilot ____________________ Control A/C ____________________

Sampler Call Sign ____________________ Alternate ____________________

Code	Information	Example	1	2	3	4	5
ABLE	Pass Number	45.5					
BAKER	Altitude in Thousands Ft.	09:15					
CHARLIE	Clock Time at Penetration	30					
DOG	Average Inten. R/hr. (Jasper)	75 secs.					
EASY	Time in Cloud (mins. or secs.)	.9					
FOX	Integr. Dose Roentgens	.5					
GEORGE	Cockpit Backgrnd. R/hr (Jasper)	.6					
HOW	Wing Tank Reading R/hr	No					
ITEM	Snap taken (yes or no)						

NOT TO BE REPORTED TO A/C

INDICATED AIR SPEED 270 ____________________

COCKPIT INTENSITY ON LANDING (JASPER) ____________________

INTEGRON READING ON LANDING ____________________

TIP TANK READING ON LANDING (ION CHAMBER) ____________________

TIME LANDING READINGS TAKEN ____________________

TAB "F"

CORRESPONDENCE RELATIVE TO
STUDIES OF EXPECTED LAGOON CONTAMINATION ON OPERATION CASTLE

3 Incl
1 JTF SEVEN ltr 725.3x903 to CTG 7.3, Subj: Lagoon Contamination and Health Hazards During Operation CASTLE, dtd / May 1953.
2. Ltr J-16961, TG 7.1, Subj: Lagoon Contamination and Health Hazards During Operation CASTLE, dtd 22 Apr 1953, w/2 Incl.
3. M/R, JTF SEVEN, dtd 29 Apr 1953.

HEADQUARTERS
JOINT TASK FORCE SEVEN
Washington 25, D. C.

AG/729.3x903 4 May 1953

SUBJECT: Lagoon Contamination and Health Hazards During Operation CASTLE

TO: Commander
Task Group 7.3
Washington 25, D. C.

1. References.

a. Letter, J-16961, TG 7.1, subject as above, 22 April 1953 with two inclosures (Incl 1).

b. Memorandum for Record, JTF SEVEN (Incl 2).

c. Draft of Radiological Safety Annex to JTF SEVEN Operation Order 1-53 (Incl 3).

2. Reference 1a outlines technical details expected to influence surface operations in the Eniwetok and Bikini lagoons following contaminating nuclear events; reference 1b outlines some of the operational aspects of such activities and indicates the scope of discussions which have taken place to date. Reference 1c delineates proposed operational clearance limits for Operation CASTLE and is included for its particular impact on ship and boat operations.

3. The above references indicate the current status of several preliminary studies of the problem of water surface operations in the presence of radiological contamination. It is desired that your headquarters take action as follows:

a. Review reference 1c and submit comments or recommendations consistent with the philosophy of "operational necessity" and "calculated risk" inherent in the over-all mission of the Joint Task Force.

b. Initiate studies to determine methods of preventing concentration of radiological contamination in water evaporators, distribution lines and microorganic growths on the bottom of ships.

c. Recommend a date for a conference with this headquarters on the over-all aspects of the lagoon contamination problem. This conference should take place as soon as possible after the assignment of

CTG 7.3 and will include representatives of BuMed, BuShips, Op-36, TG 7.1 and AFSWP with sufficient stature in the radiological field to lend assurance and practicality to the ultimate solutions of this problem.

d. Following the above conference, initiate an indoctrination program for operational personnel of your organization to inject the recommended solutions into operational problems.

BY COMMAND OF MAJOR GENERAL CLARKSON:

s/Robert H. Cushing
t/ROBERT H. CUSHING
Colonel USA
Actg Chief of Staff

3 Incl
1. Ltr, J-16961, TG 7.1 22 Apr 53, subject: "Lagoon Contamination and Health Hazards During Operation CASTLE" w/2 Incl
2. M/R, JTF SEVEN, dtd 29 Apr 53
3. Draft of RadSafe Annex to JTF SEVEN OpOrder 1-53

Copy Furnished:
Deputy Commander for Scientific Matters
CTG 7.1

HEADQUARTERS
TASK GROUP 7.1
JOINT TASK FORCE SEVEN
Los Alamos Scientific Laboratory
J Division, P. O. Box 1663
Los Alamos, New Mexico

J-16961

22 April 1953

TO: Commander
Joint Task Force Seven
Washington 25, D. C.

FROM: Scientific Deputy
Joint Task Force Seven
Washington 25, D. C.

SUBJECT: LAGOON CONTAMINATION AND HEALTH HAZARDS DURING OPERATION CASTLE

1. Recent studies of lagoon contamination and health hazards from radioactive fall-out of Castle have indicated that although the lagoons of Bikini and Eniwetok will be contaminated no serious health hazards will be experienced at time of re-entry. (Enclosures 1 and 2)

2. In all probability, ships that re-enter the lagoon following detonation of atomic devices on the surface or near the surface will become contaminated with radioactive materials. The problem that results from this action is the decontamination that may be necessary at the end of the operation. Water evaporators, water distribution lines, and microorganisms adhering to the bottom of the ships will tend to concentrate the radioactive materials to a degree that U. S. Navy ships may require some decontamination at the completion of operations in order to meet the final clearance standards of 15 milliroentgens per day as specified by the U. S. Naval Radiological Safety Regulations of 1951. (Par. 8.3) *

3. "'Final Clearance'" as defined in paragraph 25 of the Handbook of Atomic Weapons for Medical Officers (Nav Med P-1330) "indicates that ships, aircraft, and other material require no further control from the standpoint of radiation." "'Operational Clearance' implies that contamination exists and special operating procedures are required. Operational clearance for ships, aircraft, or heavy equipment may be granted by the commanding officer when he is assured by the Radiological Safety Staff that the personnel tolerance limit will not be exceeded by their use." In the past no time limitation has been placed on the rate of accumulation of the total dose (3900 milliroentgens per operation) since under this concept, the Scientific Task Group was able to take advantage of the time intensity factor of radioactive decay of fission products and minimize the time necessary for the preparation of succeeding detonations. Under such a concept, the Naval Task Group may enter contaminated lagoons of several hundred milliroentgens shortly after detonation

Incl 2 to TAB "F"

without exceeding the Task Force tolerance limit, and without the inordinate delay between shots that would result from unrealistic contamination limits.

4. Navy vessels exposed to "operational" contamination will be naturally decontaminated by radioactive decay and dilution by the open sea so that extensive decontamination should not be necessary upon their return to the United States.

5. In consideration of the above and with a view to economy and minimization of radiation exposures, it is recommended that:

a. CJTF 7 establish operational clearance limits in occupied spaces aboard ship that will permit maximum working periods within radiologically contaminated waters for vessels under his control.

b. The Commander of Task Group 7.3 be advised of these limits and of the requirement to operate in radiologically contaminated waters.

c. Studies be initiated to determine methods of preventing concentration of activities in water evaporators, distribution lines, and microorganic growths on the bottom of ships.

ACG/JDS/ek

s/Alvin C. Graves
t/ALVIN C. GRAVES
Scientific Deputy
JTF-7

Enc. 1. Lagoon Contamination During Operation Castle, J.D. Servis, TU-7, TG 7.1 dtd 11 March 1953

2. Extract: Health Hazards of Operation Castle, T.L. Shipman, M.D., H-Div., LASL, dtd 6 March 1953

OFFICE MEMORANDUM

11 March 1953

TO: Duncan Curry, Deputy for Administration
Task Group 7.1, JTF 7

FROM: John D. Servis, Commander TU-7
Task Group 7.1

SUBJECT: LAGOON CONTAMINATION DURING OPERATION CASTLE

SYMBOL: J-16513

REF:

1) Diffusion in Bikini Lagoon, W. H. Munk, G. C. Ewing and R. R. Revelle. Transactions, American Geophysical Union, Vol. 30 No. 1 Feb. 1949.

2) Preliminary Report on the Oceanography of Bikini Atoll. Operation Crossroads.

3) Radiological Decontamination of Target and Non-Target Vessels, Director of Ship Material Technical Inspection Report, JTF1, Operation Crossroads.

4) Radiological Safety Regulations, Bureau of Medicine and Surgery, U. S. Navy Department, Washington, D. C.

5) H-Division memorandum. Health Hazards of Operation Castle.

1. Introduction

The concept of Operation Castle has pointed out a requirement for ships to re-enter Bikini Lagoon following detonation of atomic devices on the surface or near the surface of the lagoon. These ships would be limited in number, but would be required for shop and laboratory work in preparation for succeeding shots. This study is therefore undertaken to evaluate the health hazards and contamination problems that might result from ship re-entry into contaminated lagoons. Technical information was obtained from Scripps Institute of Oceanography, La Jolla, California; Health Division, LASL, Los Alamos, and the laboratory records of Task Unit 7. It is felt that this study may be of assistance in the operational planning of Castle and therefore is presented at this time.

It may be expected that less than 10% of the total quantity of fission products will be deposited in the waters of the lagoon. At H + 1 hour, the intensity at the surface is expected to exceed 400 R/24 hrs. Radioactivity will be present in the area from fission products trapped in the liquid fall-out. The neutron flux resulting from the bomb, especially in the barge shots, will induce activity in water and bottom sediments. The three important neutron absorbers in sea water are hydrogen, sodium, and chlorine, but the only element of concern is sodium 24, which is of little concern after three days.

2. Bikini Lagoonal Circulation

The circulation of Bikini Lagoon is dominantly wind driven. During the spring months when winds average 20 knots from the east-northeast the current motion is vigorous, 0.5 knots in the surface and 0.3 in the bottom currents. The currents set downwind on the surface and roughly against it on the bottom. The surface current is free to move with the wind but the bottom current is restrained somewhat and tends to align itself with the major east-west axis of the lagoon. The zone of upwelling along the eastern reefs is thus a permanent feature under all winds having an easterly component.

It is probable that the fully developed surface current is produced within 1000 meters of the east reef but does not obtain full development until the fetch is greater than 2200 meters. The zone of upwelling can be defined as the region of rising water over which the surface current is less than five feet thick, in which case it extends from the northern tip of Bikini Island to the southern tip of Enyu Island, having a width of from 2200 meters opposite Rokar Island to 3000 meters behind Bikini and Enyu Islands. The bottom current surfacing within this zone is found to split into two components at Bikini Island and flow parallel to the reef in opposite directions.

After Baker Day, Operations Crossroads, the fleet was forced to mov from its anchorage in the lee of Enyu Island by the arrival of radioactive water from the upwelling zone. The fleet took up position near the center of the mouth of Enyu channel where, due to southerly winds, the surface layers were composed almost entirely of oceanic waters and the radioactive water was by then so thoroughly mixed with large volumes of clean water that it no longer held any threat to the safety of the ships.

Oceanic water flows into the lagoon continuously over the eastern and northern reefs. The total volume of flow is about three percent of the volume of the lagoon per day. Continuous outflow occurs through the western part of Enyu channel. Elsewhere, channels, passes, and the western reef, the current reverses with the tide. As the oceanic water flows in, it is absorbed into the rotary circulation of the lagoon thus gradually renewing the lagoon water, while at the same time the latter is being flushed out of the southwestern passes at a rate of 3.2% per day. At this rate of flushing, any given mass of water in the lagoon will, on the average, be reduced to one-half its original volume in 22 days and to one tenth its volume in two and a half months.

3. Diffusion of Radioactivity in Bikini Lagoon

In lagoon surface detonations it is likely that radioactive product will be distributed from surface to bottom with higher concentrations

being expected in the surface layers. The patch of contaminated water, originally more or less ellipsoid, will be elongated rapidly by currents flowing west at the surface and east at the bottom. The contaminated water at the surface will be diluted by vertical mixing with underlying water at an estimated rate of 25% per hour. The reduction in the concentration of the bottom water moving eastward from the target area is about 8% per hour.

Therefore, part of the radioactive products will be carried away from the target area, but part will be transferred by vertical diffusion to the other current and will be carried back again. Thus a strip of contaminated water is developed which lengthens westward with the speed of current flow, but with rapidly diminishing concentration, and eastward with the speed of the bottom current. The maximum concentration will remain eastward of the target area.

At the end of the first day the strip of contaminated water should be about seven miles west-southwest of the target area. The concentration at the western end of the strip is expected to be about 0.01% of the initial value taking into account vertical and horizontal diffusion but neglecting radioactive decay. At the eastern end of the lagoon the average concentration should be about 1% of the initial value, but some patches may have a concentration of 10% or more.

During the second day, contaminated water will begin to leave the lagoon by a series of ebb tide pulses through the southwestern passes. The amount leaving the lagoon will be very small at first and will increase during the first week or so to a maximum value of about 3% of the total contaminant in a day's time. Thereafter the rate of loss will be about 3% of the remaining contaminant per day.

4. Eniwetok Lagoonal Circulation

The circulation of Eniwetok Lagoon is similar to that of Bikini in that it is dominantly wind driven. During the spring months the current motion is vigorous from the northeastern reef to the western reef and through the southwest passage. The surface current is free to move with the wind but the bottom current is restrained and tends to align itself with the major east-west axis. There thus is formed a zone of upwelling along the eastern reef. Details of Eniwetok oceanography further than comparison with Bikini are not available.

5. Diffusion of Radioactivity in Eniwetok Lagoon

In lagoon surface detonations, or near lagoon surface detonations, radioactive products will be distributed from surface to bottom with the higher concentrations in the surface layers. Within the first twelve hours radiation levels will be extremely high, but radioactive decay accompanied by horizontal and vertical diffusion will tend to

distribute this activity both to the east and west. Under prevailing wind conditions for the Castle concept, the great majority of lagoon contamination should be contained in the northern half of the lagoon. Change in wind conditions can cause small amounts of north and south diffusion as was exemplified during Operation Ivy.

During this operation, the lagoon was sampled for radioactivity at the surface and thirty feet below the surface on a daily basis. Station A was located at the lagoon side of the deep entrance, station B was located at the lagoon side of the wide passage, station C was located on the lagoon side of Rigili Island, station D was a lagoon location three miles northeast of Rigili Island, station E was a mid-lagoon location half way between Rigili and Runit Island, station F was a lagoon location three miles west of Runit Island, station G was a lagoon location two miles south of the detonation, and station H was an anchorage location at the Rendova buoy. Examination of the sampling results indicates that the southern portion of the lagoon remains relatively free of contamination, the southwest passage tends to remove contamination from the western sector, and the bulk of residual contamination tends to remain in the northeastern sector of the lagoon.

6. <u>Contamination Problems</u>

Ships that are required to re-enter the Bikini Lagoon or northern sector of Eniwetok Lagoon following the surface detonations will become radioactively contaminated. This does not mean that personnel aboard the vessels will be subjected to serious health hazards, but rather that water evaporators, water distribution lines, and microorganisms adhering to the bottom of the ship will tend to concentrate the radioactive particles of the lagoon to a degree that extensive decontamination procedures may be necessitated at the completion of the operation.

During Operation Crossroads, the re-entry of the non-target vessels to the contaminated lagoon was followed by a period in which radioactive materials tended to adhere to the outer shell below the waterline. The conditions here were ideal for ion-exchange and although the water itself showed an intensity of radioactivity at or near the surface of only about 10 milliroentgens per day (far below any tolerance limit) the active matter was absorbed so efficiently from the lagoon waters that within a period of three days several of the non-target vessels began to show readings of greater than 100 milliroentgens per day of gamma radiation inside the hull in the vicinity of the waterline. In addition, salt water lines and salt water systems continuously circulating water in fire mains, condensers and evaporators, began to show increasing gamma radiation readings on exterior surfaces to the extent that certain areas adjacent to these systems were in excess of tolerance.

This same phenomena was noted during Operation Ivy on the undersurfaces of the USS Lipan and in the condensers of the USS Rendova.

Under our present limits of tolerance, an unfouled ship could remain in waters of 10 mr/day indefinitely, but ships with micro-organic growths, rust, and adsorptive paints could be limited to three days per week for continuous operation.

Our contamination problem would then be considered of nuisance value rather than a real health hazard.

7. Decontamination

For operational decontamination it seems feasible to suggest the nationally accepted tolerance limit of 300 milliroentgens per week as a guide to decontamination levels for inhabited areas. Areas exceeding this limit would require decontamination before continuous habitation would be permitted.

U. S. Naval Radiological Safety Regulations (1951) specify that final clearance for vessels is set at 15 milliroentgens per day (105 mr/week). In general this limit will be reached by the time the contaminated vessels have completed roll-up operations, with the possible exception of concentrated contamination of water systems and underwater growths. The concentrated contamination may require decontamination by disassembly of water systems and removal of pipe scale.

8. Health Hazards

Radiological hazards of Operation Castle will be similar to those of previous Eniwetok operations but more extensive due to the nature of the detonations. The extent and intensities of radioactive fall-out will be dependent on the meteorological conditions at the time of detonation. There can be no assurance that some of the fall-out will not land on inhabited areas or on ships of the Task Force. If this does happen, it creates an annoying situation, but in all probability not one which can be regarded as truly hazardous. Hazards from radiation both external and internal will be confined to immediate areas of detonation. Radiation tolerance limits will limit working time in some other areas.

Radiation levels at ground level within a mile of the detonation will be extremely hazardous during the first twelve hours. Radiation decay may be expected to follow an approximate 1/T relationship. Radioactive lagoon dilution can also be expected to follow an approximate 1/T relationship. This would mean that lagoon contamination at a single spot on the second day would be 1/4 that of the first day, on the third day 1/9 that of the first day.

9. Conclusions

a. Bikini Lagoon will become contaminated throughout as a result of current movements and diffusion of radioactive particles both horizontally and vertically.

b. Eniwetok Lagoon will become partially contaminated as a result of current movements and diffusion of radioactive particles. Southern portions of the lagoon are expected to remain clear of contamination.

c. Radioactive contamination of the lagoon will be dispersed so rapidly that serious health hazards will not exist after a reasonable time. (Re-entry hour)

d. Ships that re-enter Bikini Lagoon and the northern portions of Eniwetok Lagoon will become radioactively contaminated and may require decontamination after completion of the operation.

10. Recommendations

a. All agencies of the Task Force should be informed of the Task Group requirement to work in contaminated areas following the preliminary detonations.

b. All personnel of the Task Force should be informed of the nature of the health hazards while in the contaminated lagoon.

c. Efforts should be made by all ship commanders to minimize possible concentration of contamination so that a minimal amount of decontamination work will be required upon the completion of the operation.

John D. Servis
Commander, TU-7

J-16962

Extract: Health Hazards of Operation Castle, T. L. Shipman, M. D., Health Division, LASL, 6 March 1953

This is in somewhat belated reply to your memo of 13 February 1953. I have purposely been slow in answering in order that I might have full opportunity to discuss the matter thoroughly with those people whom I consider the best authorities on these problems. My comments will be general rather than specific and will perhaps cover a good deal more territory than was actually required by your request.

As far as actual health hazards at Operation Castle are concerned, there is not much one can say except that they will be similar to those at previous Eniwetok operations only more so. The possibilities and the dangers of fall-out should be no greater than has been the case in the past. With detonations of high yield it becomes extremely difficult to predict the shape and location of the fall-out pattern. Some material obviously is coming down somewhere, and there can never be any positive assurance that some of this will not land on inhabited islands or on ships of the Task Force. If this does happen, it creates an annoying situation, but in all probability not one which can in any way be regarded as truly hazardous. It must be admitted that some uncertainties regarding this matter still exist, and if all conditions were just right, it might be possible to produce a situation more than annoying, at least in the immediate vicinity of the shot islands.

One situation which will be somewhat different from previous tests involves the necessity of having ships of the Task Force enter contaminated waters. It is difficult to assess the amount of trouble this might cause, but examination of the pertinent data from Operation Crossroads indicates that the contamination which will be acquired by ships operating in such waters may be a nuisance but will not approach hazardous conditions.

29 April 1953

MEMORANDUM FOR RECORD

SUBJECT: Ship and Boat Operation in Radiologically Contaminated Lagoons

1. Over a period of the last 2½ months, considerable discussion has been given to the possibility of radiological contamination being trapped in an atoll lagoon to such an extent as to hamper Naval activities and thereby indirectly cause delays in the operation. These discussions involved representatives of JTF SEVEN (Lt Col House, Cdr Hall), TG 7.1 (Dr. Graves, Dr. Ogle, Mr. Curry, Major Servis), TG 7.3 (LtCdr Carlson, Lt Gill), BuMed (Capt Tipton, LtCdr Etter), BuShips (Cdr Hoffman, LtCdr Coates), Op-36 (Capt Walker), NRDL (Dr. Thompson), AFSWP (Capt Maynard, Dr. Scoville, Lt Col McDonnel), Scripps Institute of Oceanography (Dr. Revelle), and University of Washington.

2. For the purpose of this record, the following description of the Bikini and Eniwetok lagoon circulations is presented (condensed from reports on several on-site and model studies of the Bikini lagoon made in connection with Operation CROSSROADS, and from experience with Eniwetok on Operation IVY).

a. Both lagoons are essentially "belt-drive" systems, currents driven with the wind on the surface and roughly against the wind on the bottom. Upwelling zones appear in the eastern lagoon waters and sinking zones in the western portions. Bottom currents tend to remain aligned with east-west axes, roughly independent of the direction of the wind.

b. The rate of flushing of the Bikini lagoon is such that it is nearly a closed basin insofar as the interval between CASTLE shot dates is concerned, requiring 22 days to change half of the water and 75 days to change 90%. The primary flushing route is through Enyu Channel. The south-western passes account for a considerable but lesser amount of emptying. Very little, or none, of the emptying takes place over the northern and eastern reefs.

c. The Eniwetok lagoon flushing system is much more rapid, and has two major routes, i.e. through the eastern and western reefs for the northern lagoon waters and through Deep and Wide Entrances for southern waters. As demonstrated on IVY, contamination in the northern waters was flushed out without getting into the southern portion. For this reason, and considering the shot schedule, all that follows below is applicable only to Bikini lagoon operations.

d. During the spring months when winds average 20 knots from the east-northeast, the current motion was vigorous, 0.5 knots in the surface and 0.3 in the bottom currents. The currents set downwind on the surface and roughly against it on the bottom. During the summer with lighter more variable winds, the surface current sets downwind still but much more slowly (less than 0.3 knots) and the bottom current (0.1 knots) opposes it insofar as the geometry of the bottom of the lagoon permits. A zone of upwelling develops on the eastern edge of the lagoon and a sinking zone predominates over a wide area on the western side.

e. The surface current (40 to 50 feet thick) is free to move with the wind but the bottom current is restrained somewhat and tends to align itself with the major east-west axis of the lagoon. Thus even in times of southerly wind impulse when the surface current is setting north-west or north-northwest with sufficient vigor to flow out to sea over the northern reefs, the bottom current is turned only east-southeast altering the more profound transport characteristics of the lagoon very little. For this reason, the zone of upwelling along the eastern reefs is a permanent feature under all winds having an easterly component.

f. The zone of upwelling can be defined as the region of rising water over which the surface current is less than 5 feet thick, in which case it extends from the northern tip of Bikini Island to the southern tip of Enyu Island having a width of from 220 meters opposite Rokar Island to 3000 meters behind Bikini and Enyu Islands. The northerly setting component is weak, joining the drift along the northern reefs which can be detected as far west as Amen Island. The southerly setting component is both stronger and more voluminous, flowing with a mean velocity of 0.3 knots southward to the Enyu Island eddy where it is deflected upward by the sill at Enyu Channel under the inflowing oceanic water from the southeast. This geometry causes the two currents to spiral horizontally in a combined westerly setting current extending from surface to bottom which can be detected as far west as Rukoji Channel. The path of this spiral is deflected by the tides inward on flood and outward at ebb.

g. From the above, it is apparent that contaminated areas will be elongated east and west. Due to settling of contamination and diffusion in the water, both horizontally and vertically, the bottom currents will tend to spread out the elongated area, throwing up contamination in the eastern upwelling zone. Previous studies indicate an approximate 7 day cycle of turnover in the lagoon. It has been determined that the contamination at the end of one day will have been reduced by currents and diffusion alone to the following: Western sinking zone, 0.01% of original contamination; eastern upwelling zone, 1.0% of original contamination, with patches up to 10%.

3. Without going into great detail, and as a result of the above discussions, the following conclusions are apparently acceptable to those directly concerned with ship and boat operation in the presence of radiological water contamination:

a. Little lagoon contamination should result from the deep water surface shot. Something on the order of 10% of the total radioactivity from the remainder of the shots should eventually be deposited in the lagoon. Using this assumption, a 200 KT shot should give about the same results as Bikini BAKER; or 1 MT about five times BAKER, etc. The following BAKER results are presented for comparison:

Dimensions and Maximum Exposure Rates of Contaminated Water in Bikini Lagoon (BAKER)

Time After Explosion (hours)	Contaminated Area ($mile^2$)	Mean Diameter (miles)	Maximum Exposur Rate (r/day)
4	16.6	4.6	75
38	18.4	4.8	10
62	48.6	7.9	.5
86	61.8	8.9	1
100	70.6	9.5	0.6
130	107.0	11.7	0.2
200	160.0	14.3	0.01

b. No health hazard should exist after any shot; the principal adverse effect should be limited to an operational nuisance. From the above BAKER results, one could expect to operate in the lagoon at the end of 24 hours for reasonable lengths of time, with the situation rapidly improving daily.

c. After a period of a few days, diffusion and currents should have spread contamination from the shot sites to all parts of the lagoon.

d. Reduction in the intensity of radiation in the water should take place at a rate governed by at least $1/T^2$, with the probability that the reduction will be more rapid (based 1/T for radioactive decay and 1/T for diffusion in the water).

e. Critical ships and boats: CURTISS, LSD, LST, AN, ATF and small craft of the boat pools.

f. Residual contamination resulting from intake of lagoon water and discharge upon completion of its function (such as takes place through condensers) should leave little radioactivity except where trapped in pipe fittings at bends in water lines. It is expected that such "hot-spots" should not be hazardous and could be marked off for isolation; also, flushing occasionally with uncontaminated water should help remove some of the trapped sediment.

g. Some contamination will stick to the sides and bottoms depending upon the condition of cleanliness, with clean vessels picking up very little in this manner. An effort to have ships report for the operation as clean as possible would help here. Also the best possible dry dock side and bottom paint work would be a great help.

h. Some contamination will remain behind in the evaporators, although some of this should be flushed through. This source of contamination could be reduced by making water outside the lagoon. No appreciable amount of contamination should come through the evaporator to the fresh water side.

i. The relative costs of a major decontamination operation (several thousand dollars) should be weighed against the cost of a delay in the operation. Also, the value of opportunities for authentic field tests of a ship's crew in decontamination operations should be considered.

j. The Operations Orders should spell out clearly a set of more realistic operational standards applying for atomic tests as opposed to those designed for routine operations. An attempt of this kind has been made in Operations Order 1-53.

k. Many of the radiation standards published to date are particularily over-cautious, having large factors of safety built-in. This was particularly true of standards for ship operations during CROSSROADS, some of which were carried to such extremes as to cause costly delays or extremely difficult and cumbersome methods for getting the job done. Since that time, the realities of the situation have become more and more apparent and efforts have been made to feed indoctrination training into operational methods. The fact remains, however, (as evidenced on IVY) that operational commanders and staffs are extremely hesitant to proceed with assurance in such matters. This is perfectly understandable in view of the fact that the radiological defense field is relatively young and since many radiation standards and associated predicted effects have yet to be sorted into their real values or relationships. Much of the latter has been done; however, considerable improvement could be made toward injecting this knowledge into operational problems. It is believed that indoctrination as proposed below could go a long way toward paving the way for a smooth operation through a more realistic approach to the true nature of the operational nuisance expected to exist in the Bikini lagoon.

4. In view of the primary dependence of the Bikini shots on water transportation, it is proposed to hold a conference with CTG 7.3, his Chief of Staff, Operations Officer and Radiological Defense Staff as soon as possible after these people can be assembled. This conference would be called for the express purpose of acquainting CTG 7.3 and his staff with the realities of the health hazards facing a commander operating in contaminated waters, together with pertinent administrative and logistic implications arising from such operations. The Naval personnel indicated in paragraph 1 above represent the policy-makers in

the radiation field of Navy Operations. Most of the personnel indicated in paragraph 1 above have indicated either a desire for such a conference, or a willingness to present pertinent viewpoints if called upon to do so.

s/ R. A. House
t/ R. A. HOUSE
Lt Col, USAF
Chief, Tech Ops Branch

TAB "G"

RADSAFE OFFICE

The information in this tab is presented in support of the discussions on the Radsafe OFFICE in the text of the main report and as a collection of pertinent miscellaneous information contained in the Project Book and not elsewhere in this report.

11 Incls:
1. Memo Critical Shot Times Operations Stations and Instructions - RADSAFE OFFICE
2. Organization and Functional Chart, Radsafe OFFICE for Critical Shot Times
3. Radops Communications Facilities (BIKINI Phase)
4. Radops Communications Facilities (ENIWETOK Phase)
5. Description of Radsafe OFFICE Operations During Shot Times
7. M/R Radsafe Factors Considered at the Command Briefings
8. M/R Radsafe Briefing and Radsafe OFFICE Display Charts, w/7 Appendices
9. M/R Special Radiation Reports, w/3 Appendices
10. M/R Protection of Food and Water From Radioactive Contamination, 19 Feb 1954
11. CJTF SEVEN ltr J-3/729.3, subject: "Safety Instructions", dtd 19 Feb 1954

MEMORANDUM FOR: All Concerned

SUBJECT: Critical Shot Times Operations Stations and Instructions - Radsafe OFFICE

1. The following is a general description of the stationing and instructions for personnel connected with Radsafe operations on task force level at critical shot times.

2. All personnel, whether attached (VOCO) or assigned, will be considered under the direct control of the TF Radsafe Officer (Ch, Tech Br) during critical times. Duties assigned will be the sole responsibility of the designated individual unless special temporary arrangements are made on particular actions. All outgoing formal correspondence (including written memorandums for internal TF consumption) will be coordinated with the Ch. Tech Branch and AC of S, J-3, prior to dispatch. Since much of the information on actions during critical times (in particular just prior to, and subsequent to, H-hour) will be in verbal form, tape recorders will be used as necessary. Direct line transmissions such as ESTES to Radsafe CENTER on BAIROKO will be conducted in accordance with standard communications instructions. It is incumbent upon all members of this unit manning stations to familiarize themselves with island code names, key unit voice calls, communications network for RADOPS, etc.

3. Stations will be manned as indicated. Commensurate with space limitations in the Radsafe portion of the Operations Center, personnel in liaison or advisory capacity are expected to use Radsafe facilities, including clerical services, when required. Station locations for the BIKINI phase will be in the JOC aboard the ESTES; for the ENIWETOK phase, stations will be in the J-3 wing at the Hq Bldg on PARRY Island.

STATION	PERSONNEL
General Situation (Air and Surface) Command Briefings, and Supervisory (Includes advisories to commands external to TF)	LtCol R.A. House, USAF (Chief Tech Br, JTF SEVEN, and Radsafe Officer) and Capt R.H. Maynard, USN (Hq AFSWP) (Radsafe Advisory)
On-site Surface Situation Data and Recovery Operations (Including Transmission and Reception)	LtCol R.A. House (On-site officer) and YN1 J.A. Nevling, USN, JTF SEVEN
Off-site Surface Situation Data (Including Transmission and Reception)	Col C.S. Maupin, USA (Hq FldComd AFSWP) (Off-site and Biomedical Officer)
Air Situation Data (Including Transmission and Reception)	Col P.R. Wignall, USAF (AFOAT-1) (Radsafe Air Operations Officer), Sgt D. Jones, USAF (TG 7.4) (Air RADEX and Reception only) (Ass't Radsafe Air Opns), and A/1c R.E. Potter (AFOAT-1)

Inclosure 1

STATION	PERSONNEL
Administrative Assistance and Chronological Log of Events	YN1 J.A. Nevling, USN (Chief Clerk) and Cpl H.B. Tokheim
Liaison - CINCPACFLT/NYKOPO Fall-out Program	Mr. Al Breslin (HASL NYKOPO AEC Liaison Officer)

4. In general, "Check List" items have been assigned to the individual for whom the information is of primary interest. In a few cases, this assignment has been made to the individual whose information from other sources has a direct impact on the action required. In these latter cases, it is the responsibility of action officers to effect the necessary coordination on outgoing and incoming information. Wherever possible, action officers should pass advance informal notice of directives which will be forthcoming.

5. Separate files for each shot will be set up for the use of all members of the Radsafe OFFICE. All appropriate documents or memoranda having a bearing on the shot will be preserved in order that the files may reflect a complete history of the event.

ORGANIZATION AND FUNCTIONAL CHART, RADSAFE OFFICE FOR CRITICAL TIMES
(Numbered items indicate actions to be taken or monitored)

NYKOPO-AEC Liaison Officer
Mr. Al Breslin
(liaison with Chief Tech Branch)
1. CINCPACFLT/NYKOPO Flight tracks and data
2. Fixed station information
3. Ship station information
4. Pertinent situation charts

Chief Tech Branch & Radsafe Officer
LtCol R.A. House
1. General Supervision
2. General situation (Air and Surface)
3. Command Briefings
4. Surface RADEX (Preparation)
5. Heavy Nuclide Sampling
6. On-site situation
7. Transient shipping

Radsafe Advisor & Assistant
Capt R.H. Maynard
1. Advisories
2. Weather data

Scientific & Military Tests
LtCol A.E. Cowan
1. Technical Advisories to C/S USA & Chairman, AEC
2. Movement of S&F Material
3. Sample return
4. Technical Briefings
5. Technical Reports

On-Site Officer
LtCol R.A. House

YN1 J.A. Nevling
1. On-Site situation charts
2. Recovery Operations
3. Lagoon water sampling
4. "Low order" or "HE only" emergency plan
5. Telemetered Radiation Data

Off-Site & Biomedical Officer
Col C. S. Maupin
1. Weather Island Data
2. Water sampling at populated atolls
3. Air sampling at ENIWETOK and BIKINI
4. Waiver of MPE
5. Staff action on overexposures
6. Health aspects of Heavy Nuclide Sampling
7. NYKOPO-AEC flight info
8. Off-Site surface information charts

Radsafe Air Operations Officer
Col P. R. Wignall

Ass't - Sgt D. Jones, TG 7.4

W/O R.E. Potter (APOAT-1)
1. WB-29 cloud tracking reports
2. Multi-engine a/c Radsafe reports ("Sweet-Sour")
3. Cloud sampling team & Control B-36 Radsafe Reports (GILDA Reports)
4. Air RADEX
5. Constant altitude balloon data
6. Air situation charts

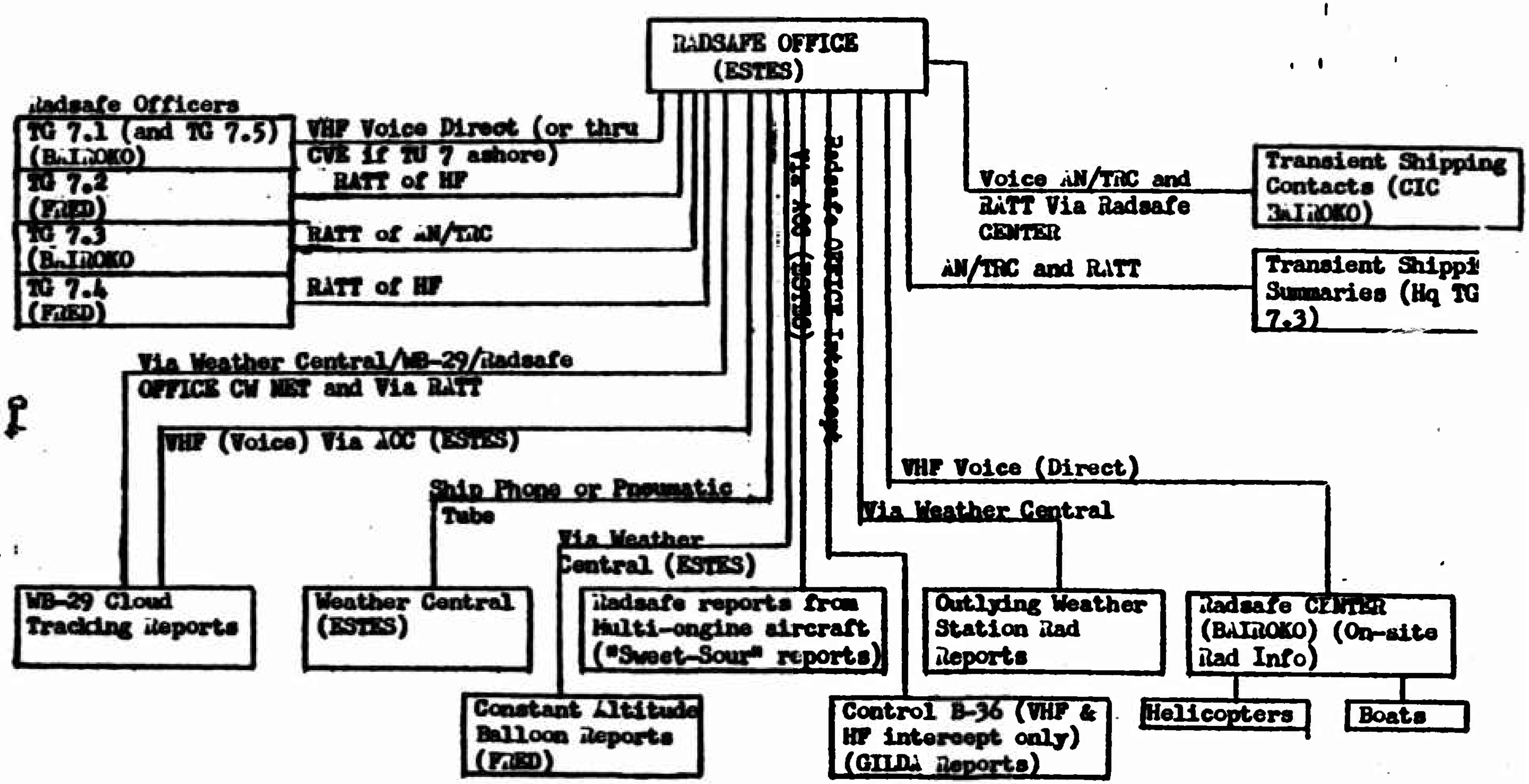
Chief Clerk
YN1 J.A. Nevling

Ass't - Cpl H.J. Tokheim
1. Administrative assistance (including steno & typist support for Radsafe OFFICE)
2. Chronological log of events
3. Special correspondence & TWX files for shot times
4. Tape recording & transcription

G-3

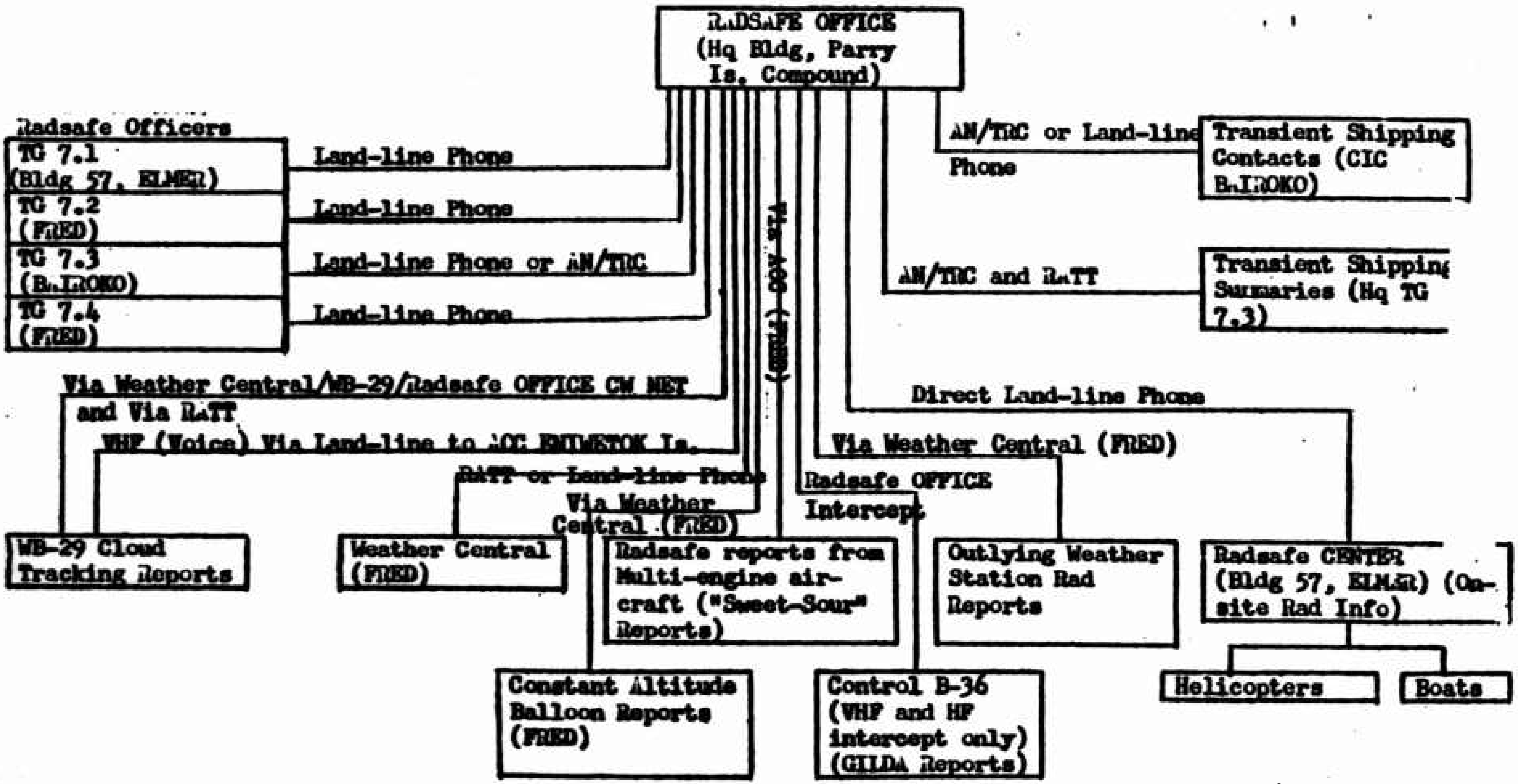
Inclosure 2

RADOPS COMMUNICATION FACILITIES (BIKINI PHASE)
(All communication lines are two-way unless otherwise indicated)



Inclosure 3

RADOPS COMMUNICATION FACILITIES (ENIWETOK PHASE)
(All communication lines are two-way unless otherwise indicated)



PRIOR TO D-5 DAYS

1. The critical shot phase of Radsafe operations will begin on or about D-5 days. Prior to this time preliminary planning will have included such arrangements as those for the receipt of coded Radsafe data on the shot atoll and the atomic cloud, wide area Radsafe flights and fixed station data, details of the heavy nuclide sampling, and preparation of charts in the Radsafe OFFICE for the display of pertinent information. Drinking water samples will have been taken from the weather islands (and at such other locations as possible) for background count and to evaluate fall-out in these areas. Administrative arrangements will have been made to record the events during the shot phase for historical purposes. Special requirements of projects or units will have been assembled for use in briefings or in providing required services. Special instructions will have been issued relative to alert and evacuation of ENIWETOK Atoll following BIKINI shots. Task force rehearsals will have been completed and the various functions of the office will have completed exercising all circuits to be used, including the transmission and reception of drill messages.

D-5 DAYS

1. On or about D-5 days, CJTF SEVEN, upon consideration of the weather and technical aspects will announce that the shot will be turned on. This action is the basic decision upon which the timing of many task force actions, including Radsafe, depend. CINCPACFLT, C/S, USA and Chairman, AEC will be notified that a shot is proposed in five days and will be given the proposed shot hour. These advisories (as well as subsequent advisories to these agencies) will be dispatched Operational Immediate and over two separate circuits to ensure delivery. In addition to the shot schedule, CINCPAC will be advised that the ENIWETOK and BIKINI airstrips will be closed for approximately 24 hours for operational reasons. A special pre-shot advisory will be dispatched to KWAJALEIN as required.

2. On shots subsequent to the first, the necessity for evacuations will be re-examined in light of the experience gained. Also, the need for waiver of MPE (Maximum Permissible Exposure) for specified personnel will be resolved at about this time (D-5 days).

3. By this date, TU 7 of TG 7.1 (designated Radsafe CENTER during critical shot times) will have published a detailed recovery plan. This plan will attempt to anticipate all possible circumstances which may arise in order that alternate recovery operations may be put into effect as required by the radsafe situation.

4. By this date, the lagoon water sampling plan will be complete. In general, the sampling will be done by TG 7.3 (the task group having primary interest in the results). Sampling devices will be lowered on a line from a helicopter to take samples at the surface and at about 90 feet (i.e., in both the surface and the bottom lagoon currents). The sampling positions have been chosen to provide the maximum information of interest

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for ships or boats anchoring or operating in the Lagoon and are further positioned to check the lagoon flushing and circulation mechanism. Lagoon samples will be turned over to the radio-chemistry laboratory of the Radsafe CENTER for analysis.

5. At about this time, TU 7 will publish an emergency Radsafe Plan to go into effect in the event of a low-order detonation, or the extreme condition of a detonation of the high explosive only. This plan is primarily a defense against the Alpha contamination resulting from the wide spread of the unfissioned material and of other Alpha emitters used in conjunction with certain shots.

D-4 DAYS

1. Sample return plan details will be completed and personnel and equipment checked for readiness. Arrangements will be completed to maintain records on the status of contamination (early and secondary fall-out) on task force ships. The radiation reports system from multi-engine aircraft will be checked for readiness and adequate information placed in the hands of TG 7.3 and TG 7.4 personnel.

D-3 DAYS (Move aboard AGC for BIKINI Shots)

1. PBM operational personnel will be alerted to the possibility of drinking water sampling at inhabited atolls outside the danger area. The ultimate necessity for such sampling will hinge on the forecast cloud movements and upon cloud tracking and ground monitoring information gathered from a variety of aircraft (both task force and those in support of NYOO) and fixed (NYOO) ground stations. During this day a request will be passed to CTG 7.3 reference the significant sector for P2V-type aircraft to sweep for transient shipping. The plan in general includes attempts to turn-out all transient shipping whose track would place them in a region 500 NM from GZ by H-hour. Previously, CINCPACFLT had been requested to exclude routing of U. S. shipping from a sector area centered on GZ and extending southwest through north to east to a distance of 500 NM for the period H to H plus 24 hours. Consequently, the P2V's are expected to encounter only foreign shipping within or heading toward the potential fall-out area. (Note: After BRAVO, this was designated a Danger Area, centered on 12N, 164E with limiting bearings of 240° and 95°, and a radial distance of 450 NM. The search plan was then modified to be run on D minus 1 day, with 3 P2V's in Area GREEN and 2 P2V's on parallel search out to 600 NM in the significant forecast fall-out area. Post-shot searches were made as necessary. Area GREEN was that area bounded by 10-15N, 16-40N, 160-10E and 170-20E.)

D-2 DAYS

1. Arrangements will be completed for the receipt of constant altitude balloon fixes. The balloons will be set to fly at about 45,000 feet (i.e., about 10,000 feet below the expected tropopause height). Using differential ballast/helium release to control pressure flight altitude, the balloons should spell out the air particle trajectory (and the expected cloud trajectory) for the flight altitude. The balloons transmit an HF signal capable of HF/DF fixing. Fixing for 72 hours per balloon will be done by

CINCPACFLT, the results forwarded to the balloon unit on FRED and relayed to the Weather Central and Radsafe OFFICE.

2. Transient shipping information (position, speed and heading) will be obtained from TG 7.3 sources (Hq TG 7.3 and CIC of CVE) and plotted for use in command briefings in order that it may be considered in relation to the forecast fall-out. A request will be passed to CTG 7.3 reference the significant sweep sector for the P2V on D minus 1 day. (See Note above reference change in search plan.)

3. The proposed position of the YAG's (drone liberty ship fall-out study) will be obtained in order that all possible services may be rendered to this project. Although project personnel will determine the desired position for their ships, position information is necessary in order to evaluate the effect of subsequent changes in forecasts.

4. At about 1800M the first command briefing will be held. (This briefing may be scheduled for D minus 3 days as well, and may consist of a TWX recap of the situation.) The briefing will consist of an analysis by the Staff Weather Officer of the weather situation expected for shot time, and an analysis by the Staff Radsafe Officer of the expected fall-out implications of the weather forecast. These factors will be weighed by CJTF SEVEN in relation to the Scientific Director's evaluation of the technical readiness of the devices and the scientific projects, and task group commanders' evaluations of task group preparations. The weather and radsafe forecasts will be general in nature, but of sufficient detail to confirm or modify the scheduled shot date. In view of the detailed progressive planning schedule followed by technical and military units preparing for the shot and due to the dependence of fall-out on the forecast wind structure, the key factor to be considered by the command briefings will normally be weather.

D-1 DAY

1. The plot of transient shipping will be made current and will include the results of the D minus 2 day P2V sweeps. (See Note above reference change in search plan.) The second command briefing will take place at about 1100M and will consider the same factors (in greater detail) as the first briefing. Forecast and observed wind hodographs will be plotted and forecast surface RADEX and fall-out plots constructed for shot time. Recommendations will be made at the command briefing and (if approved) passed to CTG 7.3 reference shot time position of the fleet. Recommendations will be made reference the CINCPACFLT H minus 18 hour advisory.

2. Following the command briefing (at about H minus 18 hours) CINCPACFLT will be advised of the forecast cloud trajectories for H to H plus 72 hours at altitudes up to tropopause height, of the Radsafe outlook for native populated atolls, and will be given recommendations reference closing of air and surface routes due to cloud drift. Also, a similar special advisory will be dispatched to KWAJALEIN.

3. The C/S, USA (Executive Agent) and Chairman, AEC will be advised of the scheduled firm shot hour and date.

4. The forecast air and surface RADEXES will be passed to all task group commanders with special copies going to CTU 7 and the Air Controller in the AOC of the command ship. These RADEXES will cover the period of H to H plus 6 hours and will be modified post-shot as required. In addition, the forecast GZ winds up to maximum significant altitude will be passed for information to CTG 7.3 and TU 7 (Radsafe CENTER).

5. The sample return plan and communication channels will be checked for readiness. Sample return aircraft will be checked for readiness.

6. The transient ship plot will be brought up to date based on reports from the D minus 1 day P2V sweeps. Additional P2V sweeps will be requested for D-day if required.

7. At H minus 8 hours, CTG 7.4 will be directed to conduct Flight #1, WB-29 Cloud Tracking from H plus 2 to H plus 14 hours. This flight will attempt to determine the hazard likely to drift and fall out on ENIWETOK and/or UJELANG and the hazard up-wind from the shot atoll, and the northern Marshalls.

8. At about H minus 12 hours, a skeleton briefing (winds and weather only) will be given for the commander.

9. The final detailed command briefing will take place at about 0000M hours and will cover the same factors as the 1100M D minus 1 day briefing, except that the basic weather data (and resultant command decision) should be more reliable than on previous briefings.

10. In the event of significant modification of the forecast weather (as transmitted in the H minus 18 hour CINCPACFLT advisory) a modification advisory will be dispatched accordingly. CINCPACFLT will be advised of the basic radiological information at H minus 18 hours due to the fact that a delay in this type advisory until after the midnight command briefing might result in receipt of the information by CINCPACFLT too late for practical purposes. On the other hand, a forecast as early as H minus 18 hours has a good chance of being significantly in error. Consequently, an H minus 18 hour forecast with an H minus 6 hour modification (if required) was considered as a suitable compromise. KWAJALEIN advisories will be treated in a similar manner.

11. At about H minus 3 hours and H minus ½ hour pertinent communication circuits will be checked for readiness and a final Weather/Radsafe check will be made for the commander.

H-HOUR

1. Beginning at H-hour, the VHF or HF intercept of the Control B-36 will be monitored for cloud reports (i.e., heights, positions and size of segments).

2. At about H plus 5 minutes the safety of any groups occupying TARE or NAN will be checked. Damage (if any) at this time would be the result of

thermal, blast or water wave. Radiation damage (fall-out) should not occur until about H plus ½ to H plus 1 hour and should not extend beyond about H plus 3 to H plus 4 hours. However, continuous checks will be made starting at about H plus 30 minutes.

3. At H plus 30 minutes, CINCPACFLT, C/S, USA and Chairman, AEC will be advised of exact shot date and time and general safety of task force personnel. The advisories going to C/S, USA and AEC will contain perliminary technical information (approximate yield, etc) as is known at this time.

4. At about H plus 1 hour, the pertinent data pertaining to the heavy nuclide sampler will be obtained from the Airborne Scientific Director together with the proposed penetration time. This information will be used to make an evaluation of the health aspects of the proposed operation.

5. At about H plus 1 hour (and continuing) radsafe information telemetered from critical stations (including TARE camp) will be obtained for evaluation.

6. During the period from H-hour to about H plus 6 hours, cloud information will be collected from the sampling team (and Control B-36 GILDA Reports) to establish the initial break-up intensities and drift of major segments of the cloud. During this time the WB-29 cloud tracker (Flight #1) should contact any segment likely to drift and fall out on ENIWETOK or UJELANG. Also, provision has been made for all multi-engine aircraft to report radiation encountered ("Sweet-Sour Reports"). Aside from the on-site value of this information to evaluate re-entry action and to verify or modify the RADEXES, the cloud information collected during this period will be used primarily to assist later decisions relative to the need for evacuation of ENIWETOK or UJELANG (or any other populated atoll). Prior to shot day ENIWETOK Atoll and the task force fleet will be covered by a representative number of film badges in order that an average dose may be assigned each individual in the event of fall-out.

7. At about H plus 2 hours the radsafe aspects of the heavy nuclide sampling mission will be evaluated. Also, at about this time, air and surface RADEXES will be modified if necessary.

8. At H plus 4 hours, a directive will be passed to CTG 7.4 to conduct Flight #2, WB-29 cloud tracking for the period H plus 12 hours to H plus 24 hours. This flight will attempt to determine the hazard up-wind from the populated atolls in the southeast quadrant and the hazard existing on (or likely to drift on) the air routes through WAKE.

9. At about H plus 3 or 4 hours, KWAJALEIN will be advised, if necessary, by special dispatch of significant changes brought about by cloud observations up to this time.

10. At about H plus 4 hours (i.e., after the on-site fall-out should have ceased), some early recovery in areas of low contamination may be attempted. Also at about this time a helicopter damage and Radsafe survey of all islands will begin. In general, this helicopter must avoid rain

showers and areas of high contamination (i.e., areas reading on the order of 10 r/hr). It is anticipated that the bulk of this early Radsafe survey will consist of aerial readings extrapolated to the ground for most of the hot islands. At about this time lagoon water samples will be taken in the anchorages near TARE. This information will receive rapid evaluation for use in the re-entry decisions. Lagoon samples in other regions will be accomplished as soon as possible. About this time air sampling equipment previously set up on site TARE, the CVE and ENIWETOK will be checked for positive indications. Data received up to this time will be reduced to a formal Radsafe summary to CJTF SEVEN for his information. This summary will contain a recommendation relative to the evacuation of ENIWETOK/UJELANG or any other populated islands as required.

11. About H plus 6 hours, damage survey, lagoon water sampling and Radsafe survey results should be available from the Radsafe CENTER. Based on the above, a recommendation will be made to CJTF SEVEN reference the designation of R-hour (Re-entry hour) and the designation of the unrestricted land and water areas. This recommendation will make particular reference pertaining to lagoon traffic ana to unloading of ships at site TARE and on the feasibility of limited or full-time occupancy of site TARE. It is anticipated that, should conditions be favorable for unloading at TARE, TG 7.3 ships, after unloading, should plan to move outside the lagoon for about 48 hours. This is due to the fact that the circulation and flushing mechanism of BIKINI Lagoon is such that the arrival of contamination at normal anchorages could be delayed for as long as 40 to 45 hours (or more). In the event TARE is not habitable, the Radsafe CENTER will operate from pre-prepared positions on NAN if possible, otherwise from afloat.

12. In the event that fall-out on populated islands becomes, or is forecast to be critical, or trade routes are affected for more than 24 hours, CINCPACFLT will be advised accordingly at about H plus 6 to H plus 12 hours. Pertinent off-site data will be passed to the Radsafe CENTER and decision reached as to the need for drinking water sampling at populated atolls outside the danger area.

13. At about H plus 8 hours the status of the first and second sample return aircraft will be checked and released or delayed contingent upon the status of sample collection and recovery operations and the approval of the Scientific Director or CTG 7.1.

14. At about H plus 10 hours another summary of the Radsafe sutiation will be prepared for CJTF SEVEN, with particular reference to ENIWETOK/UJELANG (or other off-site atolls).

15. During the period H plus 6 to about H plus 18 hours, a check will be made of the weather island fall-out situation, i.e., during the time debris could arrive at these locations.

16. At H plus 16 hours, CTG 7.4 will be directed to conduct Flight #3, WB-29 cloud tracking from H plus 24 to H plus 36 hours. This flight will attempt to determine the ultimate drift of high segments of the cloud and the extent of any contaminated area in the vicinity. It will be a vectored type flight plan, the determination of which will depend greatly on the results of the H to H plus 16-hour operations. (This flight may not be

necessary dependent upon conditions prevailing at the time.)

17. At 2000 local time a routine advisory will be passed to CINCPACFLT covering the same information as in the H minus 18 hour messages, but modified by current data if necessary. Also, at this time, a preliminary technical and operational advisory will be dispatched to C/S, USA and AEC.

18. A summary will be prepared for CJTF SEVEN, and the Radsafe CENTER will be advised on the latest situation off-site.

D PLUS 1 DAY

1. Normal recovery operations begin. The first detailed Radsafe survey will be made early in the morning of this day. A list of personnel over-exposures will be obtained for study of the contributing factors to the over-dose.

2. At H plus 28 hours the need for Flight #4, WB-29 cloud tracker (H plus 36 to H plus 48 hours) will be evaluated and CTG 7.4 notified accordingly

3. During this day a continuing effort will be made to obtain and analyze all off-site radiation data available from such additional sources as NYKOPO aerial survey flights and NYKOPO fixed stations. The Radsafe CENTER will be notified accordingly, as the information has an impact on drinking water sampling.

4. Lagoon water sampling will continue in order to maintain a continuous check of the radiation intensities at critical points and to serve as a che- against the circulation pattern for subsequent shots.

5. Additional islands will be released from Radsafe restrictions as they get below about 10 mr/hr.

6. At about H plus 36 hours the status of the third sample return aircraft will be checked and released or delayed as required (subject to the approval of the Scientific Director or CTG 7.1).

7. At 2000 local time routine CINCPACFLT, C/S USA and AEC advisories will be dispatched.

D PLUS 2 DAYS

1. Normal recovery operations continue. Prior to scheduled departure of the AGC from the BIKINI area, personnel over-exposure records will be checked and the D plus 2 detailed Radsafe survey results obtained from the Radsafe CENTER. The remainder of the day will be essentially a repeat of D plus 1, all of which can take place regardless of position of the AGC. In the event unusual circumstances arise, selected members of the Radsafe OFFICE will remain at BIKINI as required. The fourth (last) sample return aircraft will be checked at about 1600 and released or delayed as necessary (subject to approval of the Scientific Director or CTG 7.1).

D PLUS 3 DAYS

1. Normal recovery operations continue. This day will essentially be a repeat of D plus 2 days.

2. Preliminary technical reports will be obtained where possible and for use in appropriate advisories.

D PLUS 4 DAYS

1. Recovery continues, essentially a repeat of D plus 3 days.

D PLUS 5 DAYS

1. Data recovery operations will be assumed completed on D plus 4 days insofar as they pertain to Radsafe cycling for the next shot. Results of the open sea fall-out collectors will be evaluated for possible use on subsequent fall-out predictions.

(NOTE: The above description will apply on all shots with appropriate modifications on the ENIWETOK phase and on the last shot.)

RADSAFE OFFICE CHECK LIST FOR CRITICAL TIMES

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
1	D-10		Issue cloud tracking code flimsies and booklets to WB-29 squadron, weather stations, CTU 7 and Weather Central (House).
2	D-10		Issue Control B-36 and Multi-engine Radsafe codes to CTG 7.4 and CTG 7.3 (copies to CTU 7) (House).
3	D-10		Brief WB-29 Radsafe officer reference details on cloud tracking (House).
4	D-10		Assist in briefing of heavy nuclide sampler crew (in conjunction with Dr. Plank and Col Houghton) (House-Maupin).
5	D-10		Check status of task group film badge lists for CTU 7 (House).
6	D-10		Prepare system for preserving all shot time correspondence, TWX's, verbal information and tape recorded information (Nevling).
7	D-10		Radsafe CENTER operational on CVE by DX minus 2 days (Servis).
8	D-10		RADSAFE OFFICE operational on AGC by DX minus 1 day (House).
9	D-10		Pass drill advisory messages to CINCPACFLT (Maynard), and exercise Radsafe communication circuits (All). Check voice intercept of Control B-36 (Wignall).
10	D-10		Complete listing of special requirements for projects for use in briefing (House).
11	D-10		Check distribution of high density goggles (House).
12	D-5		Based on 5 day forecast, CJTF SEVEN orders execute for shot (House monitor).
13	D-5		First CINCPACFLT advisory (info CINCPAC, COMHAWSEAFRON and COMNAVMARIANAS) on proposed shot time (dual op messages); include recommendation for closing ENIWETOK and BIKINI air strips for operational reasons from about 1300M D-1 to about H plus 7 hours. (Maynard)
14	D-5		First Special Advisory to KWAJALEIN (House-Wignall).

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ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
15	D-5		First C/S USA and Chairman AEC advisories on proposed shot time (dual op messages) (Cowan).
16	D-5		Check status of codes and flight briefing for WB-29's-(House).
17	D-5		Re-examine need for complete evacuation for U, Y, N, R based on results of previous shots (House).
18	D-5		Evaluate waiver of MPE for next shot (Maupin).
19	D-5		Get detailed recovery plan from J-3, TG 7.1 (House).
20	D-5		Check lagoon water sampling plan with Radsafe officer, Task Group 7.3 and 7.1 (House).
21	D-5		Get plan for "low order" or "HE only" type detonation from CTU 7 (House).
22	D-5		Review heavy nuclide sampling plan with TG 7.4 Operations and Dr. Plank (House-Maupin).
23	D-4		Check status of sample return plans (Cowan).
24	D-4		Arrange for receipt of TG 7.3 ship intensity reports (House).
25	D-4		Arrange for "Sweet-Sour" report system with AOC (Wignall).
26	D-3		Brief Sample Return Project Officers (Cowan).
27	D-3		Alert JTF SEVEN operational personnel for possible PHM off-atoll water sampling problems (Maupin).
28	D-3	2000	Pass forecast fall-out information to JOC reference significant sector for P2V sweep on D minus 2 days (House)
29	D-3	2000	Move aboard AGC (BIKINI shots only).
30	D-2	0800	Radsafe OFFICE operational on AGC (Hq Compound for ENIWETOK shot) (House).
31	D-2	0100	Radsafe CENTER operational on CVE (Bldg 57 for ENIWETOK shot) (Servis).
32	D-2	1200	Arrange for receipt of constant altitude balloon fixes from Weather Central (Wignall).
33	D-2	1200	Get transient ship plot from CIC of TG 7.3 thru CTU 7 (House).

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
34	D-2	1800	Get latest information from CIC of TG 7.3 thru CTU 7 reference psotion of YAG's (Maynard).
35	D-2	2000	Pass forecast fall-out information to JOC reference the significant sector for P2V sweep for D minus 1 day (House)
36	D-2	H-36hr	First command briefing with existing hodograph and transient ship plots (may be TWX briefing only). Execute order confirmed (House).
37	D-1	0900	Get transient ship plot from CIC of TG 7.3 thru CTU 7 (House).
38	D-1	H-19 hr (about 1100)	Second command briefing with existing and forecast hodograph, 72-hour trajectories and transient ship plots. (Execute order confirmed.) Confirmation made reference task force ship and Control DDE positions (See below) (House).
39	D-1	H-18hr	Second CINCPACFLT advisory (info CINCPAC, COMHAWSEAFRON and COMNAVMARIANAS) (dual op messages). Includes 72-hour cloud trajectory, Radsafe outlook for native populated atolls and recommendations for air and surface routes (Maynard).
40	D-1	H-18hr	Second Special Advisory to KWAJALEIN (House-Wignall).
41	D-1	H-18hr	Second C/S USA and Chairman AEC advisory (dual op messages) (proposed shot time) (Cowan).
42	D-1	H-18hr	Pass forecast fall-out plot to JOC reference the significant sector for P2V sweep in conjunction with Area GREEN (House).
43	D-1	H-18hr	Forecast H-hour winds passed to CTG 7.3 and Radsafe CENTER (Maynard).
44	D-1	H-18hr	Forecast air and surface RADEXES (including circular surface RADEX around GZ) for H-hour to H plus 6 hours. Pass to Task Group Commanders (special to CTU 7 and AOC ESTES). Recommend task force ship and Control DDE positions to TG 7.3 with prior concurrence of, and info copy to, AOC and CTG 7.4 (Maynard).
45	D-1	H-18hr	Check radio circuit with CTU 7 (House).
46	D-1	1000	Check sample return aircraft for readiness (Cowan).

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
47	D-1	H-13hr	Get transient ship plot from CIC of TG 7.3 thru CTU 7, and summary from TG 7.3 (House).
48	D-1	H-12hr	Final check of "sweet-sour" report system through the ESTES AOC (Wignall).
49	D-1	1800	Third command briefing (winds and weather only) (execute order confirmed) (House).
50	D-1	H-8hr	Pass directive to CTG 7.4 reference Flight #1, WB-29 cloud tracking (Pass informal notice through Weather RATT and ACC voice channels) (Wignall).
51	D-1	H-8hr	Check radio circuit with Radsafe CENTER (House).
52	D-1	2000	Pass forecast fall-out plot to JOC reference significant P2V sweep for D-day if necessary (House).
53	D-1	H-7hr	Fourth command briefing with existing and forecast hodograph, 72-hour trajectories and transient ship plots. Execute order confirmed (House). Confirmation passed to CTG 7.3 and CTG 7.4 reference task force ship and Control DDE positions if required (Maynard).
54	D-1	H-6 hr	CINCPACFLT modification advisory dispatched (including info addees) (dual op messages) if required (Maynard).
55	D-1	H-6hr	Special KWAJALEIN advisory modified if necessary (House-Wignall).
56	D-1	H-5hr	Modified forecast air and surface RADEXES for H-hour to H plus 6 hours if required. Pass to TG Commanders (Special relay to Radsafe CENTER via direct radio) (Also, special to ESTES AOC) (Maynard).
57	D-1	H-5hr	Modified forecast H-hour winds passed to CTG 7.3 and Radsafe CENTER (re-modify as required)(Maynard).
58	D-Day	H-3hr	Check voice intercept of Control B-36 (Wignall).
59	D	H-3hr (and H-½hr)	Final informal check of weather and Radsafe situation and final execute confirmation (info Radsafe CENTER (House-Maynard).
60	D	H-20min	Turn off all radios.
61	D	H/5min	Turn on radios and monitor Control B-36 intercept (Wignall)
62	D	H/5min	Check safety of ENYU group (House).

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
63	D	H/10min	Monitor Control B-36 and sampler intercept. Continuously record information to about H plus 6 hours. Transcribe all GILDA and Sweet-Sour reports as they are received (Wignall).
64	D	H/30min	CINCPACFLT (and info addees) advised of the exact shot time and general safety of personnel (dual op messages) (Maynard).
65	D	H/30min	C/S USA and Chairman AEC advised of exact shot time, approximate yield, gross technical information and general safety of personnel (dual op messages) (Cowan).
66	D	H/30min	Check radiological safety of ENYU group (House).
67	D	H/30min	Get Radsafe information and proposed heavy nuclide sampler penetration time from airborne controller (House-Maupin).
68	D	H/1hr	Get information from Radsafe CENTER radiation telemetering equipment. Re-check at intervals (House).
69	D	H/1hr	Check results of heavy nuclide sampling (House-Maupin).
70	D	H/1hr	As information permits advise JOC reference Crash Crew re-entry to airstrip (House).
71	D	H/1hr	Monitor YAG (drone) reports (Maynard).
72	D	H/3hr	Dispatch modification of air and surface RADEXES to Task Group Commanders and Radsafe CENTER if required (Maynard).
73	D	H/3hr	Check Radsafety of ENYU group (House).
74	D	H/3hr	Special post-shot advisory to KWAJALEIN through AOC (House-Wignall).
75	D	H/4hr	Pass directive to CTG 7.4 reference Flight #2, WB-29 cloud tracking (Pass informal notice thru Weather RATT and AOC voice channels) (Wignall).
76	D	H/4hr	CJTF SEVEN directs TG 7.1 "fire-ball" recovery to begin in areas of low contamination and directs TG 7.1 helicopter damage and Radsafe survey of all islands (House).
77	D	H/4hr	CJTF SEVEN directs TG 7.3 lagoon water sampling by helicopter at TARE and NAN anchorages (House).
78	D	H/4hr	Issue R-hour alert based on information known at this time (House).

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
79	D	H/5hr	Get information reference air sampling at ENIWETOK and BIKINI (Maupin).
80	D	H/5hr	Forward summary to CJTF SEVEN relative to ENIWETOK/UJELANG (or other atolls) reference evacuation requirement (House).
81	D	H/5hr	Get damage survey results and radiation readings from Radsafe CENTER (House).
82	D	H/6hr	Evaluate lagoon water sampling results (especially as pertains to unloading at sites TARE and NAN) (House).
83	D	H/6hr	CJTF SEVEN designates R-hour (Re-entry hour) to TG Commanders (special to Radsafe CENTER) and designates unrestricted water and land areas. (Special reference to possibility of secondary fall-out and to lagoon traffic and to Sites TARE and NAN for limited or full-time occupancy. Also turns over Radsafe Control of Shot Atoll to CTG 7.1 (Radsafe CENTER). (House)
84	D	H/6hr	Special CINCPACFLT advisory (including info addees) (dual op messages) dispatched if native evacuation problems arises or trade routes are affected for more than 24 hours (Maynard).
85	D	H/7hr	Check status of first and second sample return aircraft and release or delay as necessary (Cowan).
86	D	H/8hr	Lagoon water sampling in remainder of lagoon beings (TG 7.3).
87	D	H/8hr	Prepare summary of pertinent off-site Radsafe data for Radsafe CENTER (Maupin).
88	D	1200	Evaluate need for water sampling at distant atolls (Maupin
89	D	H/10hr	Check weather station Radsafe reports (Maupin).
90	D	H/10hr	Get information reference air sampling at ENIWETOK and BIKINI (Maupin).
91	D	H/10hr	Prepare re-evaluation summary for CJTF SEVEN relative to ENIWETOK/UJELANG and other atolls (House).
92	D	1500	CJTF SEVEN directs (info Radsafe CENTER) water sampling at significant atolls if necessary (arrange with MilOpns for PBM support and Radsafe CENTER for personnel and equipment)(Maupin).

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
92	D	H+12hr	Check and evaluate weather island Radsafe reports (Maupin)
93	D	H+12hr	Get information reference air sampling at ENIWETOK and BIKINI (Maupin).
94	D	H+12hr	Check FRED and ELMER intensities (Maupin).
95	D	H+12hr	Get informal preliminary technical reports from TG 7.1 (Cowan).
96	D	H+15hr	Get information reference air sampling at ENIWETOK and BIKINI (Maupin).
97	D	H+16hr	Pass directive to CTG 7.4 reference Flight #3, WB-29 cloud tracking. (Pass informal notice through Weather RATT and AOC voice channels.) (Wignall)
98	D	2000	Dispatch CINCPACFLT advisory (including info addees) (dual op messages). Include information as in H minus 18 hour forecast modified by current data. Include results of aerial surveys flights. (Maynard)
99	D	2000	Dispatch C/S USA and Chairman AEC advisories (dual op messages) (Cowan).
100	D	2000	Dispatch summary of off-site radiation data to Radsafe CENTER (Maupin).
101	D	2000	Check weather station Radsafe reports (Maupin).
102	D	2000	Prepare summary report on Radsafe situation to CJTF SEVEN (House).
103	D+1	0800	Get list of over-exposures from Radsafe CENTER (Maupin).
104	D+1	H+28hr	Pass directive to CTG 7.4 reference Flight #4, WB-29 cloud tracking. (Pass informal notice through Weather RATT and AOC voice channels) (Wignall).
105	D+1	1000	Get detailed Radsafe survey results from Radsafe CENTER (House).
106	D+1	1100	Get NYKOPO flight results (pass information to Radsafe CENTER if pertinent to off-site water sampling) (Maupin).
107	D+1	1100	Evaluate lagoon water sampling results (House).
108	D+1	1100	Check weather station Radsafe reports (Maupin).

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
109	D/1	1600	Check status of third sample return aircraft and release or delay as necessary (Cowan).
110	D/1	2000	Pass summary of off-site Radsafe data to Radsafe CENTER (Maupin).
111	D/1	2000	Prepare Radsafe summary for CJTF SEVEN (House).
112	D/1	2000	CINCPACFLT advisory (including info addees) (dual op messages) Include results of aerial survey flights (Maynard).
113	D/1	2000	C/S USA and Chairman AEC advisories (dual op messages) (Cowan).
114	D/2	0800	Get list of over-exposures from Radsafe CENTER (Maupin).
115	D/2	1000	Get detailed Radsafe survey and lagoon sampling results from Radsafe CENTER (House).
116	D/2	(Approx)	Depart BIKINI on AGC.
117	D/2	1600	Check fourth sample return aircraft and release or delay as necessary (Cowan).
118	D/2	1700	Get NYKOPO flight results (info Radsafe CENTER if pertinent to off-site water sampling) (Maupin).
119	D/2	1700	Prepare summary of off-site Radsafe data to Radsafe CENTER (Maupin).
120	D/2	2000	Prepare Radsafe summary for CJTF SEVEN (House).
121	D/2	2000	CINCPACFLT advisory (including info addees) (dual op messages) include results of aerial survey (Maynard).
122	D/2	2000	C/S USA and Chairman AEC advisories (dual op messages) (Cowan).
123	D/3	0800	Get list of over-exposures from Radsafe CENTER (Maupin).
124	D/3	0900	Get informal preliminary technical reports from TG 7.1 (Cowan).
125	D/3	1200	Get NYOO flight results (info Radsafe CENTER if pertinent to off-site water sampling) (Maupin).

ITEM NO	DAY	HOUR	EVENT (Names in parens indicate "action by")
126	D/3	2000	Prepare summary of off-site Radsafe date for Radsafe CENTER (Maupin).
127	D/3	2000	Prepare Radsafe summary for CJTF SEVEN (House).
128	D/3	2000	CINCPACFLT advisory (including info addees) (dual op messages) include results of aerial surveys (Maynard).
129	D/3	2000	C/S USA and Chairman AEC advisories (dual op messages) (Cowan).
130	D/4	0800	Get list of over-exposures from Radsafe CENTER (Maupin).
131	D/4	1000	Get detailed Radsafe survey and lagoon water sampling reports from Radsafe CENTER (House).
132	D/4	2000	Prepare summary of off-site Radsafe data for Radsafe CENTER (Maupin).
133	D/4	2000	Prepare Radsafe summary for CJTF SEVEN (House).
134	D/4	2000	CINCPACFLT advisory if necessary (dual op messages) (Maynard).
135	D/4	2000	C/S USA and Chairman AEC advisories if necessary (dual op messages) (Cowan).

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MEMORANDUM FOR RECORD

SUBJECT: Radsafe Factors Considered at the Command Briefings

1. Hodographs and Resultant wind diagrams; forecast winds for H Hour:

a. For each briefing hodographs were constructed for all pertinent observed winds since the previous briefing in order to show development of the wind pattern. Forecast winds for H Hour were also presented in hodograph form.

2. Surface RADEX H to H plus 6 hours, limited bearings, radial distances, hot area, cool area and long range fall-out plot.

a. Using the hodograph for forecast H Hour winds, the surface RADEX was indicated by drawing bearing lines from ground zero enclosing all wind vectors from surface to 60,000 feet and all winds between 60,000 and 90,000 feet. A fifteen degree sector was added to each limiting bearing line. A representative, or average, radial distance was indicated for a six-hour period of fall. A hot and a cool area were indicated, the hot area being the sector from surface to 60,000 feet; the cool area being that area inclosed by bearing lines 60,000 to 90,000 feet. The long-range (24 hour) fall-out plot (drawn over a chart of native atolls and populations) was presented in conjunction with the surface radex.

3. Seventy-two-hour air particle trajectory forecast:

a. The air particle trajectory forecast (constructed by the Weather Central) was used to approximate sampling areas, to evaluage contaminations on air routes and to extend the surface RADEX beyond H plus 6 hours.

4. Air RADEX: Since the air RADEX does not normally affect the shot decision, it was not directly used at briefing, unless requested. This RADEX was plotted and kept displayed in the RADSAFE OFFICE.

5. Outlooks:

a. BIKINI: The outlook for BIKINI was determined from the forecast hodograph for the shot atoll.

b. ENIWETOK: The outlook for ENIWETOK was determined from the forecast hodograph for the shot atoll.

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c. UJELANG: Both the long-range fall-out plot and shot atoll hodographs were used to evaluate the outlook for UJELANG.

d. Native atolls in southeast quadrant: Both the fall-out plot and shot atoll hodographs were used to evaluate the outlook for native atolls in the southeast quadrant.

e. Control destroyer: The shot atoll hodograph was used to recommend positioning of the control destroyer such that it would be safe for at least six hours, and be able to retire in the most favorable direction in the event fall-out was experienced.

f. ATF for YAGS: This subject was presented in order to indicate the major activity (drone liberty ship project) taking place within or near the surface RADEX, and within close range of the armed device prior to H Hour.

g. Air routes: (1) Through WAKE, (2) Through KWAJALEIN. The impact on the air routes was determined by the 72-hour air particle trajectory forecast. In general, the trajectories at 10,000, 20,000 and 30,000 feet were considered to have the major impact on these routes between H and H plus 24 hours.

h. Surface routes inside 500 miles (approximately one day cloud travel): A display of all known transient shipping was presented in conjunction with both the surface RADEX and the long-range fall-out plot.

i. CINCPACFLT advisories (72-hour trajectory, native outlook, air and surface routes): The general features of the proposed advisories to CINCPACFLT were presented for coordination and concurrence of the commander.

j. Position of task force ships: Based on the surface radex, recommendations were made relative to positioning the task force ships. (The influence of operational problems relative to the surface RADEX and fleet positioning were resolved by the commander and staff based on the Radsafe briefing information.)

k. The cloud tracking plan was reviewed, as necessary, and as it related to special features of specific forecast wind patterns.

6. A general over-all statement of favorability or unfavorability of the Radsafe shot conditions was given in summary and conclusion of the briefing.

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MEMORANDUM FOR RECORD

SUBJECT: Radsafe Briefing and Radsafe OFFICE Display Charts

1. Radsafe Briefing Charts: Briefing and display charts were of such size as to be amenable to easy handling, and large enough for legibility in an ordinary size room. Charts were covered with acetate for marking with grease pencil.

a. Hodograph and Surface INDEX (See Appendix 4 for miniature reporduction): Four or five of such charts were prepared (depending upon the complexity of the patterns, area of coverage, and time over which the changes in observed winds were necessary). Forecasts winds were plotted separate from observed. A notebook of miniatures of these hodographs was prepared for retention by the task force commandor and as permanent records.

b. Air Particle Trajectory Forecast Chart (USAF Weather Plotting Chart Pacific Islands, AWS WPC 5-6-2): This chart was prepared by the Weather Central on a special weather station map drawn on a scale of approximately 72 nautical miles to the inch. The chart was used at the briefing primarily for Radsafe purposes, following which it was posted in the Radsafe OFFICE for further use in preparing necessary advisories.

c. Long-range Fall-out Forecast Chart (Sheet #8 of AMS 1201): This chart, which indicates all native islands and atolls likely to be involved in the long-range fall-out, was used to present the 24-hour fall-out plot. Native populations were indicated for each inhabited atoll. A miniature of this forecast was prepared for the commander and for permanent record.

d. Danger Area and Search Area Chart (Sheet #8 of AMS 1201): Because of the close inter-relation between the fall-out plot and these subjects, relative information was plotted on the same chart as the long-range fall-out plot.

e. Transient Shipping Chart (Navy HO Chart VS-2): This chart, which covers the entire Pacific area, was used not only to present the transient shipping status, but also to maintain continuity in ship movements from one shot to another.

f. Native Population Chart (See Appendix 3 for miniature): Miniature copies of this chart were made available to the commander and staff and used with the large displays (para 1c and d above).

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2. Radsafe OFFICE Display Charts:

a. Hodographs and Surface RADEX: The charts used in the command briefings (para 1 above) were placed on display in the Radsafe OFFICE.

b. Air Particle Trajectory Forecast Chart: (Same as para 2a above).

c. Long Range Fall-out Forecast Chart: (Same as para 2a above) This chart was displayed for the primary benefit of the JOC for aircraft search interests.

d. Danger Area and Search Area Chart: (Same as para 2a above) This chart was displayed for the primary benefit of the JOC and for aircraft search interests.

e. Transient Shipping Chart (Same as para 2a above).

f. Native Population Chart (Same as para 2a above).

g. Air RADEX Chart: This chart was prepared for advisory purposes. It was used as the basis for the forecast Air RADEX, by the AOC as a basis for aircraft vectoring, and to assist in analysis of cloud tracking.

h. Cloud Tracking Chart (Sections of USAF LR Nav charts of scale 40 NM per inch): This chart was used to plot cloud tracker flight patterns and to record in-flight reports from these aircraft.

i. On-site Radsafe Situation Charts (ENIWETOK, No. HO 6033; BIKINI, No. HO 6032)(See miniatures in Appendices 1 and 2): These charts were used to record post-shot Radsafe survey results and displayed for the information of all interested sections. An acetate over-lay of the IVY MIKE iso-intensity pattern for H plus 3 hours was also displayed on these charts.

j. Off-site Radsafe Situation Chart: This chart was a composite of several area maps, to indicate coverage of the AEC's New York Operations Office fall-out program and results.

k. Radiation Intensities on Task Force Ships Chart (See Appendix 5 for miniature of this chart).

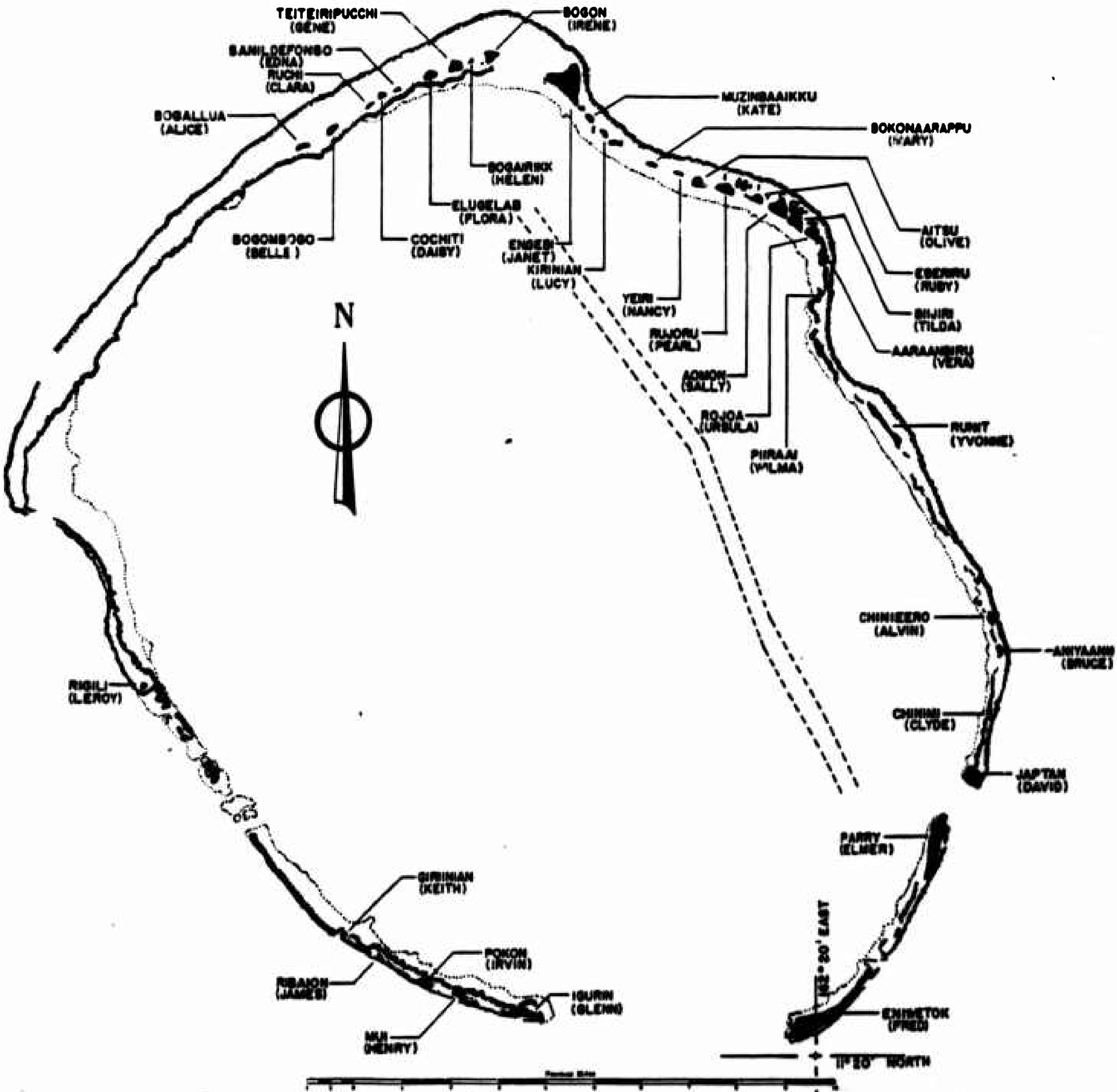
l. Chart for Status of Recovery (See Appendix 6 for miniature of this chart).

m. Chart for Critical Information (See Appendix 7 for miniature of this chart).

Appendices:

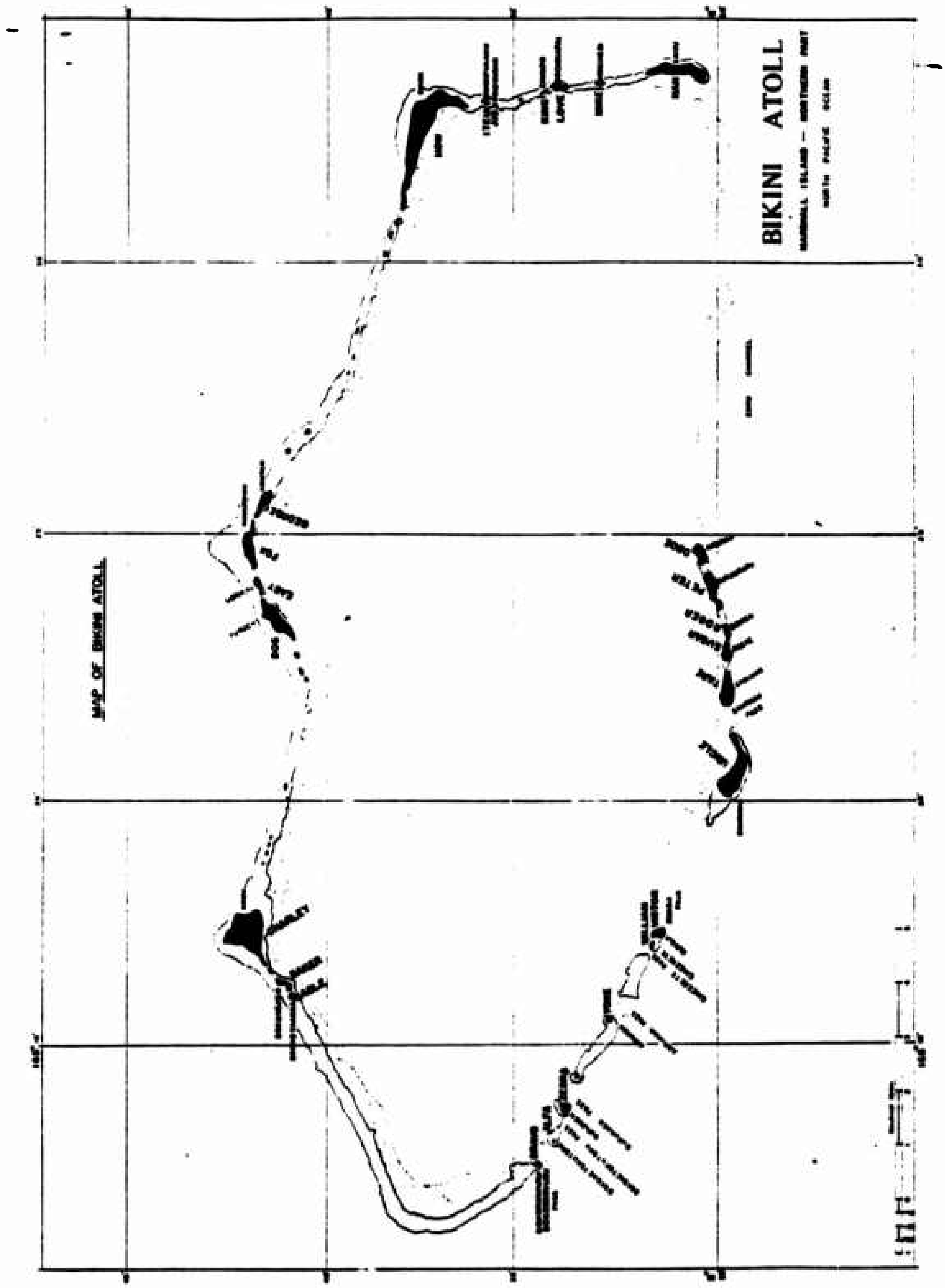
1. Map of ENIWETOK Atoll
2. Map of BIKINI Atoll
3. Native Population Chart
4. Hodograph, Resultant Wind -Surface RADEX Chart
5. Chart for Radiation Intensities on Task Force Ships
6. Chart of Status of Recovery
7. Chart for Critical Information

MAP OF ENIWETOK ATOLL



App 1

G-26a



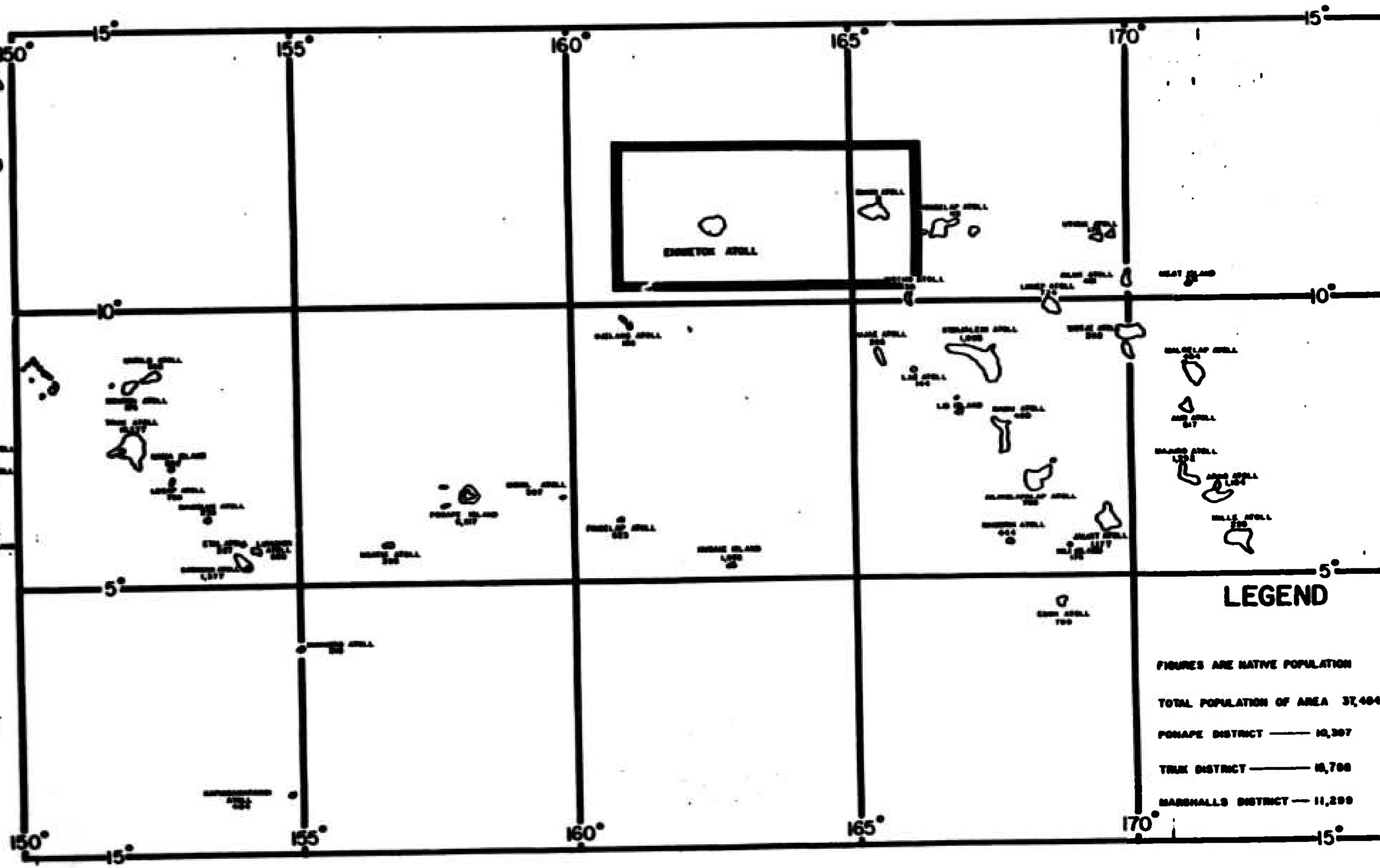
App 2

G-266

FORWARD AREA NATIVE POPULATION

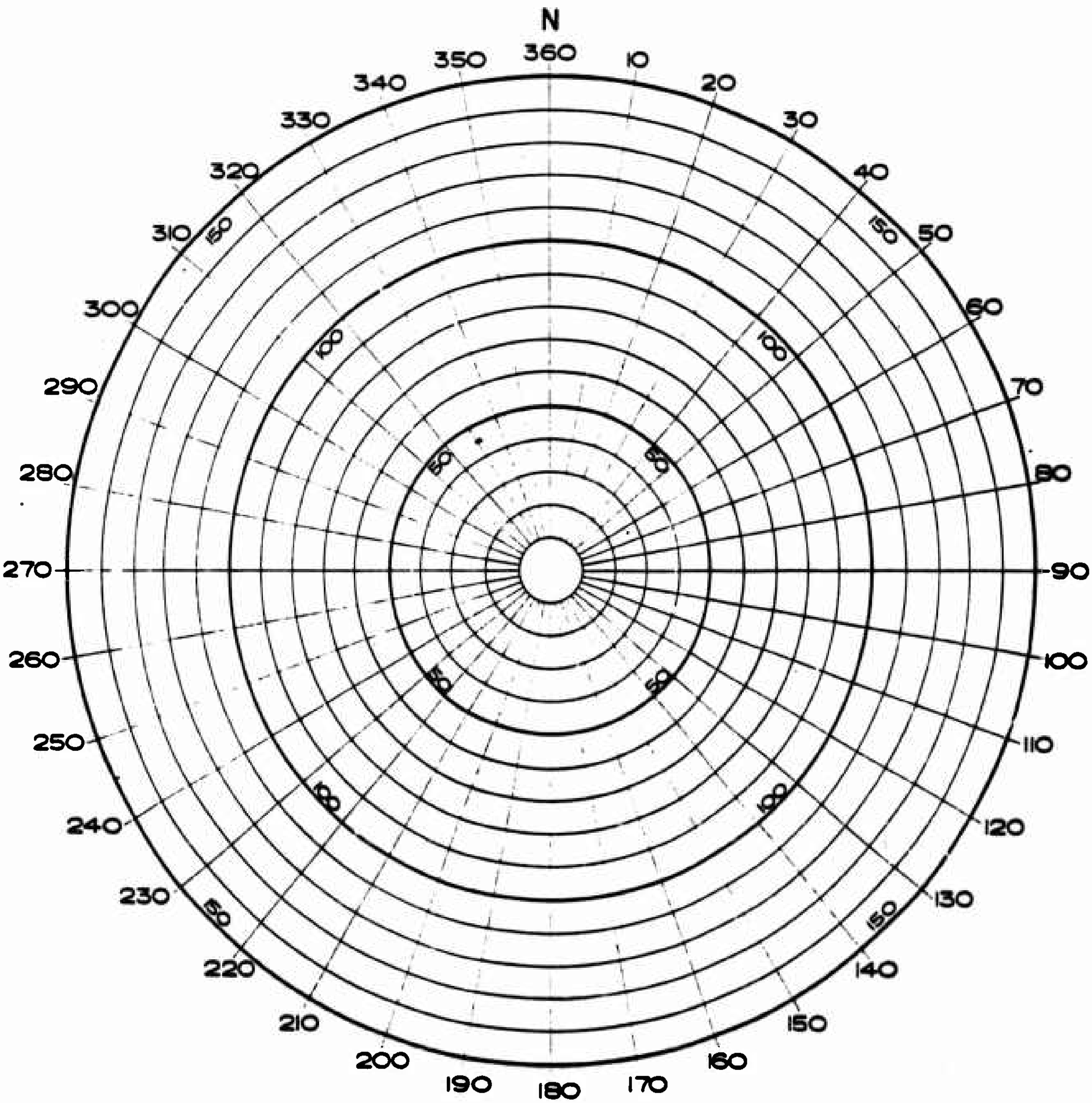
App 3

G-26c



HODOGRAPH

RESULTANT WINDS AND SURFACE RADEX



App J

G-26d

RADIATION INTENSITIES
TASK FORCE SHIPS

(SHIP READINGS "NEGATIVE" IF NOT LISTED)

SHIP	TIME	AVE γ / MAX γ	TIME	AVE γ / MAX γ	TIME	AVE γ / MAX γ	TIME	AVE γ / MAX γ	TIME	AVE γ / MAX γ	TIME	AVE γ / MAX γ	REMARKS

STATUS OF RECOVERY

PROJECT	DATE	REMARKS

App 6

G-264

CRITICAL INFORMATION

ITEM	INFO	REMARKS
CLOUD COVER (Term)		
PRECIPITATION		
VISIBILITY		
SURFACE WIND		
TROPOPAUSE HT		
BASE of WESTER'S		
TOP of TRADES		
SEA CONDITION		

App 7

MEMORANDUM FOR RECORD

SUBJECT: Special Radiation Report (In addition to reports included under Tab E, Cloud Tracking Plan)

1. A special personnel dosage report was required from each task group as of each shot plus four days. Each report was designed to be complete in itself, i.e. to include over-all totals as of the report date, of personnel in the following categories:

a. Total exposed personnel below 2.5r

b. Total personnel 2.5r to 3.9r

c. Total personnel 3.9r to 7.8r

d. Total personnel above 7.8 r

e. Maximum exposure in roentgens

2. Lagoon water sampling reports for re-entry were made by voice over the direct VHF circuit between the Radsafe OFFICE and the Radsafe CENTER. (See Appendix I for details of lagoon sampling plan.

3. Intensities on task force ships were normally reported by each ship to TG 7.3 with CJTF SEVEN as info addee. (See appendix II for details of reporting systems.)

4. Daily routine Radsafe surveys made by the Radsafe CENTER were dispatched by TWX to CJTF SEVEN with all task group commanders as info addressees.

5. Verbal (and occasionally informal written) reports were obtained from several sections on a "bonus" basis. These included the AOC, Project 6.4 (Drone Liberty Ships, ATFs and aerial relay aircraft), Project 2.5a (Fall-out Distribution) and Helicopter Damage Survey.

Appendices:
1. Lagoon Water Sampling Plan
2. Code for Radiation Intensities on TF ships
3. Sequence for On-site Radiation Reporting

LAGOON WATER SAMPLING PLAN

1. General (BIKINI)

a. Water samples will be taken from BIKINI Lagoon for measurement of radioactivity. The results of these water measurements will be used to prevent ships from being placed in water of high radioactive intensity and to obtain information on currents inside the lagoon.

b. Helicopters and boats will be used to take these samples.

c. Surface and deep samples will be taken as required. Surface samples will be taken at or near the surface. Deep samples will be taken about ninety (90) feet below the surface.

d. Before sampling, helicopter pilots or boat coxswains will be briefed as to the points and depth where samples are desired. Water sampling points are numbered and located as follows:

Water Sampling Point Number	Location (All directions true)
1	One mile northwest of northern tip of VICTOR.
2	Midway between Coca Tower and northwest tip of UNCLE.
3	Midway between Coca Tower and northeast tip of OBOE.
4	One mile north of eastern tip of SUGAR.
5	One mile north of northeast tip of OBOE.
6	Midway between OBOE and LOVE.
7	One mile west of northern tip of NAN.
8	1¼ miles west of souther tip of LOVE and ½ mile east of buoy "8".
9	One mile south of northwestern tip of HOW.
10	2¼ miles southwest of northwest tip of HOW and ½ mile west of buoy "13".
11	Midway between Coca Tower and northwest tip of HOW.
12	½ mile east of Coca Tower.
13	Midway between Coca Tower and BRAVO.
14	Midway between ABLE and BRAVO.
15	One mile south of sourheastern tip of CHARLIE.
16	Midway between Coca Tower and southeast tip of CHARLIE.
17	Midway between Coca Tower and southwestern tip of DOG, and ½ mile northwest of buoy "3E".
18	One mile south of EASY.

Estimated distances from a tower, or island, or both, as the case may be, will give sufficient accuracy for locating the above points, as extreme accuracy of location is not necessary. Whenever a sampling point appears to be at a place where the water is shallow, the deep sample at this sampling point, if one is to be taken, should be taken nearby where the water is at least ninety (90) feet deep. It should be kept in mind by helicopter pilots and boat coxswains that buoys may not remain in their proper positions.

2. Requirements.

a. After each shot, before a ship may reenter the lagoon, surface samples must be taken of that part of the lagoon where the ship is expected to go, and a determination made that the water in that area is not excessively radioactive.

b. Since primary fall-out is possible from H Hour to about H plus 4 hours, the first water samples will be taken at about H plus 4 hours.

c. If TARE is not contaminated at H plus 3½ hours, surface samples will be taken at water sampling points 1, 2, 3, 4, 5, 6, 7 and 8 starting at H plus 4 hours. This should require two helicopters and about two hours time. The samples can be measured in less than one hour, and (measurements permitting) ships proceed through Enirrikku Pass and to area just west of NAN by about H plus 7 hours.

d. Surface samples at water sampling points 9 and 10 must be taken before ships enter the area southwest of HOW.

e. Water sampling will be done primarily to protect ships and secondarily to obtain data on currents in the lagoon.

f. It is estimated that on D day two helicopters will be needed from H plus 3½ hours to sundown.

g. After D day water samples will normally be taken as follows: (assuming ENINMAN Island and Water Sampling Points 1, 2, 3, 4, and 5 are not contaminated):

(1) Points 1, 2, 3, 4 and 5 by boat.

(2) Points 13, 14, 15 and 16 by helicopter. This will require one helicopter for about two hours.

(3) Other points by helicopter if available, and by boat if no helicopter is available.

h. High priority will be given to lagoon water sampling requirements because the operation depends, among other things, upon ships being in such condition that personnel can stay aboard without receiving excessive radiation.

3. General (ENIWETOK).

a. Water samples will be taken from ENIWETOK Lagoon similar to the plan used on Operation IVY. For purposes of this document the IVY plan is attached as Appendix I.

Appendix:
I.- ENIWETOK Lagoon Water Sampl Plan (Opn IVY)

WATER SAMPLING AND REENTRY PROCEDURE AFTER MIKE AND KING SHOTS

1. Purpose. The purpose of this appendix is to outline the procedure to be followed in sampling and analyzing lagoon water prior to and after reentry of TG 132.3 ships into ENIWETOK Lagoon.

2. Scope. The sampling problem falls into three general categories, namely:

a. Samples obtained by helicopters on a regular schedule.

b. Samples obtained by small craft on a regular schedule.

c. Samples of opportunity (i.e., samples will be picked up by TG 132.1 monitors on special survey or recovery operations).

3. It is presently planned to make the first area survey of the lagoon water by helicopter at H plus 7 hours, taking water samples at the surface and at a depth of 35 feet at the following locations:

a. Wide Passage.

b. Deep Entrance.

c. Berth L-4, anchorage A (Prior to reentry to lagoon).

d. Four samples on a line running from the northern tip of RUNIT Island westward to RIGILI.

e. One sample will be taken on a line from the coral head (Mack) toward zero point, at the 100 mr/hr isointensity line at 35 feet altitude.

It is presently planned to repeat this helicopter survey at 0800M and 1600M each day until it is definitely determined that no significant amount of radioactive material exists in the lagoon waters. It is planned to sample from the surface and at depths of 35 feet from a small boat in anchorages A and B. Samples are to be taken at each of the berths where ships are moored. In addition any special survey or recovery parties which are going to an area where water samples will be of interest will be requested to obtain a water sample.

4. Analysis. After samples are collected they will be analyzed in the radiological trailer located aboard the RENDOVA. Samples will be analyzed by evaporating and counting which will give a quantitative analysis and by counting with an emersion type geiger tube which will give a good qualitative analysis.

5. Continuous Water Monitoring. A continuous water monitoring unit is being assembled for installation in RENDOVA. This unit will show a continuous trace on an Easterline-Angus recorder. In addition two units are being assembled which will provide continuous monitoring but will require reading at intervals since they do not have a continuous recorder. One will probably be installed in ESTES and the other in the ship anchored closest to the Wide Passage. When any of these monitoring units shows any significant change in radiation intensity water samples will be taken and analyzed in the radiological trailer.

6. Reporting. An evaluation of the sample analysis will be presented to CTG 132.3 at about 1100M and 1900M each day. Information which might affect operations of the Task Force will be transmitted to CJTF 132 when obtained.

CODE FOR RADIATION INTENSITIES ON TF SHIPS
(Extract from TG 7.3 OpPlan 1-53)

Change to OpPlan

Insert following page

Appendix IV to Annex G

Radioactive Fallout Reports

1. For one week following each shot each ship will report radioactive fallout encountered as follows:

a. A report will be made of fallout readings (gamma only) of 1 mr per hour or higher.

b. Only the value of gamma radiation will be reported.

c. Reports will be coded as follows: "Rabbit" followed by a number to indicate average topside activity, the number indicating mr per hour (gamma only); "Cat" followed by a number to indicate maximum activity found on the ship, the number indicating mr per hour (gamma only). Thus a message "Rabbit 2 Cat 7" indicates the average topside activity is 2 mr per hour (gamma only, and the maximum activity found on the ship is 7 mr per hour (gamma only). Fractional numbers will be reported as the nearest whole number. Thus if the average topside activity is 3.8 mr per hour (gamma only) and the maximum activity found on the ship is 8.4 mr per hour (gamma only) the message to be sent is "Rabbit 4, Cat 8". *

d. New reports will be made when either the average topside activity or the maximum activity found on the ship is different from the last previous report by 50%.

e. Reports will be sent by radio or light to USS BAIROKO and to the USS ESTES. These reports will be delivered to the RadSafe Center on the BAIROKO and to the Radsafe Office on the ESTES.

f. Reports will be sent on TG 7.3 UHF Admin or CW Common or on TG 7.1 Pogo or Admin Nets, as appropriate.

g. One week after each shot, every ship will send a letter to CTG 7.3 (marked Attn: Atomic Defense Officer) enclosing a copy of all reports of radioactive fallout originated by it since the shot occurred. Negative letter reports are desired.

SEQUENCE FOR ON-SITE RADIATION REPORTING

1. On-Site radiation intensity readings will be reported on Circuit J-313 (land-line telephone for ECHO) from the Radsafe Center to the RADSAFE OFFICE as follows:

   a. For shot atoll islands:

      (1) Island code name

      (2) Intensity reading in milli-roentgens per hour (mr/hr) (numerical reading only will be given; no reference will be made to the units of intensity.)

      (3) EXAMPLE: A report "TARE 15" indicates ENINMAN Island intensity is 15 mr/hr.

   b. For lagoon or drinking water samples, readings will be reported directly by identifying the sample station and as gamma, beta or alpha in terms of microcuries (uc) per milli-liter (ml).

      EXAMPLE: Lagoon Station 4, gamma 10^{-4}, beta 2.5×10^{-4}, alpha 3×10^{-5}.

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

J-3/729.3 19 February 1954

MEMORANDUM FOR: See Distribution

SUBJECT: Protection of Food and Water from Radioactive Contamination Resulting from Fall-Out

1. It is not expected that radioactive material will be deposited on food, cooking and eating utensils or in the drinking water supply in quantities sufficient to create an internal hazard in areas where occupancy is acceptable from an external hazard standpoint. However, in keeping with the concept that exposure should be prevented where possible, and in view of good housekeeping, certain steps should be taken to prevent or minimize contamination of food, water and mess equipment.

2. Methods of preventing contamination will vary somewhat depending upon whether or not there is pre-shot evacuation of the area.

3. The following steps to achieve non-contamination will be taken:

a. Evacuated areas.

(1) Water supply.

(a) Prior to evacuation, all openings into the wells or storage tanks will be covered by a suitable material such as canvas to prevent fall-out from entering directly into the system, but not tight enough to prevent pump operation. If possible, storage tanks for drinking purposes should be isolated from the system and completely buttoned up. This latter method is preferable as upon re-entry, water for drinking and cooking purposes can be obtained immediately which will be free from contamination. Uncovered storage in collapsible tanks should be drained, the tank collapsed and covered.

(b) Upon re-entry if fall-out has occurred, the buttoned up tank will be diverted into the water system and the lines flushed. Water samples will be analyzed before use for drinking or cooking is authorized. If no fall-out has occurred, restrictions will not be applied and sampling will not be done.

(2) Mess facilities.

(a) Prior to evacuation, utensils, dishes and silverware will be placed or packaged in such a way as to minimize breakage and scattering due to blast. Unpackaged materials will be covered to prevent fall-out from settling on them. Perishable foods will be kept in refrigerators, and dry stores and canned goods will be covered. Windows on windward side may be closed if there are windows on opposite sides at right angles sufficient to equalize pressure from blast to prevent building collapse.

(b) When the emergency utilities crew re-enters the area, it will close all mess hall and dispensary windows and doors.

(c) Upon re-entry, all dishes, silverware and utensils will be washed with hot water and detergent soap. Radiological safety survey will determine whether contamination exists prior to food preparation.

(3) Dispensaries will be buttoned up prior to evacuation.

(4) Clearance of drinking water, mess facilities and dispensaries will be required from the Staff Surgeon and Radsafe Officer prior to use of these facilities.

b. Non-evacuated areas.

(1) Water supply. The day before the shot, openings into the water system will be covered. If fall-out occurs, the covers will remain until the Staff Surgeon and Radsafe Officer consider the fall-out stabilized. If fall-out does not occur, the covers may be removed.

(2) Mess Facilities. Preparations will be made to cover food, dry stores and canned goods which are not in closed buildings prior to shot day. Upon the first detection of fall-out, the messes will be notified and buildings will be closed, and all food covered until fall-out has stopped. Survey will be made of mess facilities prior to sending food after fall-out. If survey indicates contamination of food, dry stores, canned goods, or utensils, all will be washed prior to serving. If fall-out does not occur, no restrictions will be applied.

(3) Dispensaries will be buttoned up during the fall-out period.

(4) Clearance by the Staff Surgeon and the Radsafe Officer will be require for continuing use of all facilities after fall-out has occurred.

BY COMMAND OF MAJOR GENERAL CLARKSON:

/s/ROBERT CHESNEY
/t/ROBERT CHESNEY
Major USAF
Adjutant General

DISTRIBUTION
"C"

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

J-3/729.3

19 February 1954

SUBJECT: Safety Instruction

TO: Commander, Task Group 7.1, APO 187 (HOW)
Commander, Task Group 7.2, APO 187
Commander, Task Group 7.3, APO 187 (HOW)
Commander, Task Group 7.4, APO 187
Commander, Task Group 7.5, APO 187 (HOW)

1. Reference is made to paragraph 10c, Annex A, JTF SEVEN Operation Order 3-53.

2. Attention is directed to the attached CJTF SEVEN Special Bulletin, dated 19 February 1954, Subject: "Safety Instructions", which outlines personnel safety measures to be taken during shots at BIKINI and ENIWETOK Atolls and establishes the siren warning system applicable to all personnel on PARRY Island. CTG 7.2 and CTG 7.4, in coordination, will institute similar warning systems for their personnel on ENIWETOK Island to cover at least the conditions listed in the Special Bulletin. In like manner, CTG 7.3 will institute a warning system for all naval personnel afloat. For ECHO, CTG 7.4 will adopt a comparable warning system at BIKINI.

3. Commanders will insure that safety instructions contained in the attached Special Bulletin are given widest dissemination in the form of handout leaflets and via public address systems, concurrently with the official time-signal count. Using organic communication facilities, CTG 7.1, CTG7.2, CTG 7.3, CTG 7.4 and CTG 7.5 will obtain the official time-signal count on 126.18 mcs. or 152.99 mcs.

4. Commanders will make local reporduction of the attached Special Bulletin for each shot, with modifications dictated by specific shots, local operational requirements and by their internal warning systems.

5. When so notified, personnel in Category I (as defined in the attached Special Bulletin) will report to the air base operations by the most expeditious means possible. CTG 7.4 will provide airlift for such personnel to KWAJALEIN. Personnel will remain at KWAJALEIN until further advised.

Inclosure 11

J-3/729.3 19 February 1954
SUBJECT: Safety Instructions

6. The attached Special Bulletin will be handled as CONFIDENTIAL information until after the particular shot for which it is issued. Thereafter, it may be downgraded to UNCLASSIFIED.

BY COMMAND OF MAJOR GENERAL CLARKSON:

/s/ROBERT E. BOHNE, Capt, USAF
(for)ROBERT CHESNEY
Major USAF
Adjutant General

1 Incl
CJTG SEVEN Special Bulletin, "Safety Instructions"

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

SPECIAL BULLETIN 19 February 1954

SAFETY INSTRUCTIONS

1. The following information must be passed to each person who will be in the Pacific Proving Ground on D-1 of any shot.

2. An atomic explosion will take place at the Pacific Proving Ground at a location, date and time to be announced separately. It is possible that the shot may be delayed or re-scheduled for another day. The safety instructions in this bulletin will apply regardless of the exact firing time. The siren signals indicated below will be used on PARRY Island. Similar audible signals will be sounded on ENIWETOK Island and aboard ships of the task force. In the event of failure of siren warning signals and the time-count, it will nevertheless be assumed that the shot will take place as scheduled unless otherwise notified.

3. For all shots, two categories of personnel are defined for inhabitants of other than the shot atoll:

a. Category I: Individuals who expect to enter radioactively contaminated areas on subsequent events of this series, or personnel whose current radiation dosage exceeds 3.5r.

b. Category II: Individuals who normally will not be expected to enter radioactively contaminated areas on future events of this series provided their radiation dosage is less than 3.5r.

4. BEFORE THE SHOT.

a. Shot time minus 30 minutes	All persons on or in the vicinity of the shot atoll will be awake before the shot until after the shot. Long sleeve shirts and long pants are not necessary for protection against thermal radiation. Personnel remaining on BIKINI islands during BIKINI shots will stay inside the bunker until after the shock wave has passed
b. Shot time minus 5 minutes 5 SIREN BLASTS, COUNT DOWN (Direct communication or count-down will be maintained with occupied land sites of BIKINI Atoll for shot at this location.)	In the event of siren failure, fire engine whistle will be used. Personnel on, or near, the shot atoll will not climb buildings or other structures to observe the shot. Gusts of wind are expected at occupied sites of the shot atoll exercise normal precautions to secure light objects nearby.

c. Shot time minus 1 minute
3 SIREN BLASTS, COUNT DOWN

On or near the shot atoll: Personnel having high density goggles will put them on at this time. All personnel will face away from shot site. Personnel having high density goggles may turn and view the fireball after the initial flash. Goggles will not be removed until at least 10 seconds after the burst and then gradually to allow accomodation. Personnel having no goggles will not view the fireball until at least 10 seconds after the burst and will do so then with caution. Do not look at the fireball with binoculars at anytime. Sun glasses give no protection and will not be used in lieu of high density goggles. The shock wave will travel to observation sites at a speed of approximately 5½ seconds per nautical mile, timed from first flash of light.

d. Shot time delayed
1 LONG BLAST, COUNT DOWN

1 continuous blast indicates the shot has been delayed. If there is a delay, warning blast will be repeated at SHOT minus 5 minutes and SHOT minus 1 minute before the new shot time.

5. AFTER THE SHOT (Inhabitants of other than the shot atoll will remain on fall-out alert status from H to H plus 24 hours).

a. 5 SIREN BLASTS

If 5 consecutive blasts are heard anytime after the shot, take cover in the nearest building and close all doors and windows.

b. 3 SIREN BLASTS

If 3 consecutive blasts are heard anytime after the shot, prepare to go aboard ship for a temporary evacuation. Report to your muster officer or superior at designated beach areas for further instructions. Such evacuation will be for personnel safety only and will not involve materiel or personal belongings other than toilet articles and a bare minimum of clothing change

c. Category I personnel as indicated in 3a above will be alerted through normal command channels in the event radioactive fall-out on the order of 5mr/hr or more occurs or is forecast to occur. Such personnel shoulc be instructed to assemble at a central location in order than their evacuation to KWAJALEIN by air may be effected as soon as practicable. Pre-shot arrangements must be made by task group commanders with the air base operations to schedule necessary space and pick-up details in the event an aerial evacuation of Category I personnel becomes necessary.

d. Evacuation of Category II personnel, if required, will be accomplished by all practicable means, including air lift.

6. Personnel are cautioned against discussing operations activities at the Pacific Proving Ground in letters home. It is imperative that information connected with the detonations occurring here not be released or transmitted until so authorized by the Atomic Energy Commission and the Department of Defense. Specifically, this Special Bulletin, or any of its contents, will not be included in personal mail or otherwise transmitted for personal use. Subsequent to shot plus 1 day this document will be destroyed by burning.

BY COMMAND OF MAJOR GENERAL CLARKSON:

/s/ROBERT E. BOHNE, Capt, USAF
(for)ROBERT CHESNEY
Major USAF
Adjutant General

TAB "H"

CORRESPONDENCE RELATIVE TO EVACUATION AND
REHABILITATION OF MARSHALL ISLAND NATIVES

6 Incls:

1. Copy JTF SEVEN ltr J-3/729.3, Subject: "Radiological Surveys of Several Marshall Island Atolls", dtd 18 Mar 54, w/3 Incls
2. Copy Hq JTF SEVEN ltr J-3/370.05, Subject: "Reports on Evacuation of Natives and Surveys of Several Marshall Island Atolls", dtd 9 Apr 54
3. Copy Hq JTF SEVEN ltr J-3/370.05, Subject: "Miscellaneous Reports Related to the Atomic Detonation on 1 Mar 1954", dtd 1 May 54
4. Copy Hq JTF SEVEN ltr, J-3/141.8, Subject: "Survey of Rongelap and Utirik Atolls", dtd 1 May 54
5. Copy CINCPACFLT ltr Serial 01339, Subject: "Survey of Rongelap and Utirik Atolls", dtd 17 Jun 54
6. Copy Hq JTF SEVEN ltr J-3/729.3, Subject: "Responsibilities for Care and Disposition of Native Inhabitants of Rongelap and Utirik Atoll", dtd 6 Jul 54

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW) c/o POSTMASTER
SAN FRANCISCO, CALIFORNIA

J-3/729.3 18 March 1954

SUBJECT: Radiological Surveys of Several Marshall Island Atolls

Campbell
RHC

TO: Distribution

1. Attached herewith for your information and retention are copies of radiological surveys made on certain Marshall Island Atolls. The surveys were conducted as a result of contamination deposited on the affected atolls by BRAVO Shot, Operation CASTLE, fired from a reef approximately one and one half nautical miles southwest of Namu, Bikini Atoll. BRAVO Shot time was 1845 Zebra, 28 February 1954.

2. Water and soil samples were shipped to the Health and Safety Laboratory, New York Operations Office, Atomic Energy Commission (Attention: Mr. Merrill Eisenbud) for analysis.

FOR THE COMMANDER:

E. McGinley

E. McGINLEY
Brigadier General, U.S. Army
Chief of Staff

DISTRIBUTION:

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CINCPACFLT	- Copy 36
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C/S USA, ExAgt	- Copy 43
LASL H Div.	- Copy 44
HASL, NYOO (c/o Mgr Opns)	- Copy 45-46
USS RENSHAW (DDE-499)	- Copy 47
USS PHILIP (DDE-498)	- Copy 48
USS NICHOLAS (DDE-449)	- Copy 49

3 Incls:
1. Report on Soil and Water Sampling Mission by Maj R. D. Crea
2. Report on Soil and Water Sampling Mission by Dr. R. M. White, LASL
3. Rad. Survey of Downwind Atolls Contaminated by BRAVO by Dr. Herbert Scoville

H-1

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW) c/o POSTMASTER
SAN FRANCISCO, CALIFORNIA

COMPT 8 March 1954

SUBJECT: Report on Soil and Water Sampling Mission

TO: Commander
Joint Task Force SEVEN
APO 187 (HOW)
c/o Postmaster
San Francisco, California

1. In compliance with your oral instructions, the undersigned visited LIKIE[illegible] and AILUK Atolls, JEMO Island and MEJIT Island in the Eastern Marshalls between the period 5-8 March 1954 for the purpose of collecting soil and water samples [illegible] measuring level of gamma radiation present at those places in connection with BRAVO. The mission, consisting of the undersigned and a Marshallese interpreter, Lan Lakapun, embarked on the USS BENSHAW (DDE499) at Kwajalein, visited the four sites and returned to Bikini, where the remainder of the trip to Eniwetok was performed by PBM. There follows a detailed discussion of the findings at each location:

a. LIKIEP ATOLL. The samples were taken on Likiep Island, which had t[illegible] largest native population. Access to the lagoon was gained through South Pass. Poor light at the end of the day and numerous coral heads necessitated anchoring about 4 miles from Likiep Island. Trip in was made by whaleboat the following morning. A water sample was taken from a large cistern fed from the roof of the Catholic rectory, and earth samples were taken from random spots about the isl[illegible] which were unsheltered by trees or other growth at approximately 0800 M 6, Marc[illegible] 1954. Radiation readings were takn with a MX-5 instrument between 0800 M and 090[illegible] M and showed a maximum of 3 milliroentgens per hour. No variations from this reading were noted on clothing or bare feet of individuals. According to accounts received by Bishop Feeney, S.J., the population was greatly excited by the light and blast wave, the latter which reportedly arrived about 30 minutes subsequent to the light flare. According to Bishop Feeney, church attendance was greatly stimulated on the day of the test.

b. JEMO Island. This location was reached at 1100 M, 6 March 1954. It consists of a small heavily wooded island, surrounded by a line coral reef with heavy surf on three sides. There being no place for landing a whaleboat, personn[illegible] and equipment were transferred from the whaleboat to the reef by a one man rubber raft. The undersigned transferred himself by swimming. The island proved to be uninhabited, and reportedly is a sea turtle preserve. Turtle hunters erected several houses, a rain barrel of which provided a water sample. Earth samples were gathered at random from open areas, including one of beach sand above the high tide mark. The party was led straight across the island and back to the land ing area via the beach, in order to verify its uninhabited state. Samples were

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collected at approximately 1200 M, 6 March 1954. Instrument readings with the MX-5 showed a maximum of 3 mr/hr, however this was not considered reliable, since a higher scale showed a lower reading.

c. AILUK ATOLL. The ship reached this atoll at approximately 1600 M, 6 March 1954, and slowly moved to an anchorage off Ailuk Island, the most heavily populated. The lagoon has not been swept, and numerous coral heads and pinnacles provided considerable hazard to ship movement. The landing party moved ashore by whaleboat without difficulty, and again obtained water samples from the most prominent cistern and soil samples from random unsheltered spots. Readings with the MX-5 showed approximately 3 mr/hr (off the 2 mr scale). An AN/PDR-27E showed a high reading of 7 mr/hr, however, on a different scale a reading of 12 or 15 mr/hr was obtained. The MX-5 reading is probably nearest correct. No significant variations were detected on bare feet or clothing of individuals. Samples and readings were taken at approximately 1700 M, 6 March 1954.

d. MEJIT Island. This single coral island is also surrounded by a reef, as is JEMO, but landing was possible with a whaleboat, due to an area protected from the surf. The island was found to be heavily populated in view of its size, the total number of people being 327, according to the island magistrate. Soil and water samples were taken as in the previously described manner, at approximately 1300 M, 7 March 1954. Readings with the MX-5 showed maximum of approximately 3 mr/hr (off the 2 scale, but approximately 1.5 on the 20 scale); the maximum reading with a PDR 27 E was 10 mr/hr. The true figure was probably somewhere between the two.

2. CONCLUSIONS. Low level (less than 10 mr/hr) radiation measurements with field instruments of the type used are highly unsatisfactory. One MX-5 and the AN/PDR 27 E instruments all showed widely variant readings on different scales and varied among each other when exposed to the same radiation. An AN/PDR T1-B proved completely useless not holding to zero even after an hours warm-up, and also showing widely variant readings on different scales.

3. RECOMMENDATIONS. Landing parties in islands such as JEMO and MEJIT should be provided with a rubber 6-man or 8-man pneumatic boat, to provide greater safety to personnel and equipment. This will permit landing directly on live coral reefs with less danger of the boat being stove in. Ships assigned to such missions should draw such equipment prior to departure.

4. The successful accomplishment of the mission was greatly facilitated by the interest and enthusiasm of the Commanding Officer of the USS RENSHAW, CDR L. H. Alford, USN, and his officers and men. Their material contributions were necessary to the mission, however, the many valuable suggestions and assistance in solutions of problems proved invaluable.

/s/ R. D. Crea
R. D. CREA
MAJ, USA

MEMORANDUM FOR: CJTF SEVEN 10 March 1954

SUBJECT: Report on Soil and Water Sampling Mission

1. In compliance with your oral instructions, the undersigned visited Wotje, Erikub, Maloelap, Wotho, Majuro Atolls in the Marshall Islands 5 through 7 March 1954 for the purpose of obtaining earth and drinking water samples, and of measuring gamma ray dose rates, and also checked the radiological condition of the S.S. ROQUE on its arrival at Majuro 7 March 1954.

2. The first four atolls were visited by Marshallese interpreter Takushi and the writer by means of an UF-1 amphibious aircraft. Majuro was reached by C-47. Erikub might have been omitted since it was not inhabited, being property of the Wotje tribe which goes there only occasionally to gather copra. (This was unknown until after the visit.)

3. At each atoll, only the principal inhabited island was visited. At each visited island an effort was made to compose a representative soil average by collecting into a single container several samples, each approximately one square foot of area and one inch depth. Water samples were collected from the principal sources currently in use. The gamma dose rates are averages for the inhabited areas.

4. With regard to certain minor discrepancies between the survey methods used by Major R. D. Crea and the writer; it was originally planned to perform the survey jointly, and when it became advisable to separate and survey different atolls, no time remained for discussion of details of techniques.

5. Gamma-ray dose rates on Wotje and on Erikub are each the average of MX-5 and AN/PDR-39 average readings which agreed reasonably well. The MX-5 was rendered inoperative when the rubber life raft was swamped by surf on the first attempt to launch from the beach at Erikub. Following the Wotho survey, the PDR-39 developed a temperature-dependent reading of 0.4 - 2 mr/hr, so that later readings in this range are of very dubious reliability.

6. The following tabulation summarizes the atoll survey. S is Soil, W is Water Sample:

ATOLL	ISLAND	DATE	TIME	SAMPLE NO	MR/HR & SAMPLING
WOTJE	ORMED	5 Mar	1600	S5	3.5 mr/hr, 1-beach, 3-mid-village, 1-back village.
				W6	½ well plus ½ catch basin.
ERIKUB	ERIKUB	5 Mar	1715	S6	1.5 mr/hr. 1-mid-village, 1 on path to beach. No inhabitants, no water supply found.

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8 8.5 .3

ATOLL	ISLAND	DATE	TIME	SAMPLE NO	MR/HR & SAMPLING
MALOELAP	KAVEN	6 Mar	1130	S7	1.8 mr/hr, 2-village, 2-path to beach.
				W12	Well water.
				W13	From catch basin.
WOTHO	WOTHO	6 Mar	1615	S8	0.8 mr/hr, 1 by well; 2-mid-village.
				W9	Well water (no rain in catch basin for 2 mo.)
MAJURO	ULIGA	7 Mar	1200	S9	0.5 mr/hr, 4 from near Admin Bldg.
				W10	Tap water.

7. Pacific Micronesian Line S.S. "ROQUE", Master: Lawrence Blane, home port, Guam, left Eboye 0840 M on 1 March, entered channel to Utirik Lagoon about 1200 M on 2 March, and anchored in Lagoon at 1524 M on 2 March; docked at Majuro (Uliga Is.) 1630M on 7 March. Readings (mr/hr) after docking: 2-3 inside main deck structure, 10 on open deck, 5-8 in sleeping quarters on upper deck, 10-30 on rope and canvas. Prior radiation levels cannot be estimated because of rain squalls and uncertainty about when decks last washed. Master was advised to have decks washed down as soon as convenient. He was told that the activity would not hurt anyone, but that it was undesirable to have it around longer than necessary.

8. RECOMMENDATIONS: Future visits to Erikub and Maloelap should not be attempted by UF-1 except under conditions of greater urgency. The writer's prior experience in such operations is very limited, but from his own observations plus the remarks made by those better qualified to judge, it appears that a fair amount of risk is involved.

9. Especially notable was the very cooperative attitude of the Navy personnel at Kwajalein and the Marshall District Administrative Officials at Majuro in supporting this mission.

/s/ T. N. White
DR. T. N. WHITE
Health Division
LASL

1 Incl:
Marshall Islands Atoll
Samples collected by T. N.
White, 5-7 March 1954

MARSHALL ISLANDS ATOLL SAMPLES COLLECTED BY T. N. WHITE, 5-7 MARCH 1954

Earth samples were collected as follows:

At each island visited several samples were dug and put into the same one-gallon "ice-cream carton". Each sample (i.e. each digging) approximated one square foot to a depth of one inch. The number and locations of the samples were selected to represent, as well as could be judged, an average of the areas used by the inhabitants, after the samples were mixed in the carton. Areas that were unusually shaded or unshaded by trees were avoided. The large "pebbles" in the composite represent coral gravel from "main street" through the village.

Water samples were selected according to the principal source in current use.

Inclosure 1

HEADQUARTERS TASK UNIT 13
Task Group 7.1
APO 187 (HOW) P.O. Box 8
c/o Postmaster
San Francisco, California

TU-13-54-375 12 March 1954

SUBJECT: Radiological Survey of Downwind Atolls Contaminated by BRAVO

1. Acknowledgement

The members of the survey team wish to express their appreciation to the Captain, officers and members of the crew of the USS NICHOLAS (DDE 449) for their assistance and cooperation in conducting the survey herein reported. Captain Elliot turned over all possible facilities of his ship in order to assist in the survey. LT Frink, the Executive Officer, organized all the operations of the boat parties, and it was only through his personal direction and participation that it was possible to carry out the small boat surveys under extremely difficu conditions. Since most of the lagoon waters were not navigable by a DDE, it was necessary to make long boat trips in high seas and land on tricky coral reefs. That it was possible to make, without mishap, a detailed survey of five widely separated atolls in the course of three days with only two boats was largely due to his efforts.

2. Introduction

The BRAVO Shot contaminated a number of atolls in generally eastward direction from Bikini to such an extent that it became necessary to evacuate the native populations from Rongelap, Ailinginae and Utirik Atolls and the military personnel on Rongerik Atoll. Following this evacuation CJTF SEVEN organized the subject detailed radiological survey of the atolls to the eastward of Bikini (Ref. CJTF SEVEN Eniwetok 060400Z). The data from this survey were required for the following purposes:

a. The evaluation of the radiation effects on evacuees.

b. The estimation of the elapsed time before reoccupancy.

c. The estimation of the residual radiation effects of large yields surface detonations.

In connection with this survey, teams from various Task Groups and Mr. Wilds, Trust Territory Representative, returned to the atolls to secure the evacuated habitations, service military equipment, and obtain documentary photography.

3. Operational Schedule

8 March - 0800 Survey team rendezvous aboard USS NICHOLAS (DDE 449) in Rongelap Lagoon.

2 2.5 11 13

8 March - 1000 - 1800 Two parties in small boats surveyed living areas on Rongelap Island and eastern half of Rongelap Atoll.

9 March - 0700 - 1130 Two parties in small boats proceeded from the DD. which was stationed outside Utirik Atoll and surveyed Utirik and Aon Islands, the main islands of the Atoll.

9 March - 1500 - 1700 One party in a small boat landed on the outer reef of Bikar Island and surveyed the island, the only large island of Bikar Atoll.

10 March - 0700 - 1100 Two parties in small boats proceeded from the D which was stationed outside Rongerik Atoll and survey Eniwetak Island (where the Task Force's Units had bee stationed) and the other important islands of the Atol

10 March - 1430 - 1900 Two parties in small boats proceeded from the D which was stationed outside Alinginae Atoll and surve the inhabited islands of the Atoll.

11 March - 0700 - 1400 One party in a small boat surveyed the northwe ern islands of Rongelap Atoll and one party recheck the living areas on Rongelap Island and established a reference location for future decay measurements.

12 March - 0800 Survey team arrived Eniwetok Atoll via DDE.

4. The following personnel from test projects in TG 7.1, TU 13, served as members of the survey team:

Herbert Scoville, Jr.	TU-13 Staff
Richard Rast	Project 2.1
Richard Soule	Project 2.5a
Walmer Strope	Project 6.4

The USS NICHOLAS (DDE 449) supplied boat crews under the direction of LT Cliffor Frink, Executive Officer, for surveys.

5. Instrumentation

Radiac set AN/PDR-39 was selected as the instrument to be used in the conduct of the survey. Five (5) each of AN/PDR-39 were calibrated with an 80 Curie Co^{60} source twenty-four hours before departure. The calibration yielded a zero variation between instruments - any scale. Upon cross checking three of these instruments, (a point of actual survey) in a radiation field of 0.320 r/hr it was found that all three instruments gave the same reading.

These survey meters were subject to prolonged use under adverse conditions of dampness (to the point of sea water splashing over them), salt deposit and continual rough handling. With one exception, all instruments operated efficiently for the duration of the operation. On the final day it was found

that one survey meter could not be properly zero adjusted. The four remaining AN/PDR-39, still operated efficiently and seemed to be in good working order.

- One (1) each Beckman MX-5, and one (1) each AN/PDR-27A was brought along for any low intensity checks necessary. Two (2) each calibrated AN/PDR-T1B, were on hand to serve as spares in the event of operational failure with the AN/PDR-39. None of these instruments were required.

6. The average and maximum gamma dose rates measured on the various islands of each atoll are plotted in Figures 1 through 5. All measurements were made at waist height unless otherwise indicated. The maximum readings do not include measurements made with the instrument next to a contaminated surface.

Detailed surveys were made of all the inhabited localities. Typical readings are given in Tables 1 and 2 for the native village of Rongelap Island, and the TG 7.4 camp on Eniwetak Island. In general, the villages and the camps appeared to have slightly lower average dose rates than the remainder of the island. This can perhaps be ascribed to different geometry of the contamination and to slightly greater penetration into the loose gravel in the native villages. The dose rates inside the native huts appeared to be almost the same as the dose rate outside. The dose rate in the middle of the military barracks, tents, and shacks was 1/3 to 1/2 that outside. This reduction is probably largely a geometric effect. The dose rate fell off rapidly on the beach below the high tide mark. There was no evidence of rain washing off the contaminated material. The foliage on the windward sides of the islands appeared to be slightly above average contamination.

TABLE 1

TYPICAL READINGS IN RONGELAP VILLAGE - 8 MARCH

Location	Dose Rate (mr/hr)
Rongelap Island (average)	375
Center of village	280
Near central cistern	300
Near southern cistern	220
Near northern cistern	350

TABLE 2

TYPICAL READINGS IN CAMP ON ENIWETAK IS. - 10 MARCH

Location	Outside Dose Rate (mr/hr)	Inside Dose Rate (mr/hr)
Eniwetak Island (average)	280	- -
Mess hall	220	110
Tent, edge of main camp	270	175
Latrine	260	160
Sleeping quarters	260	90
Dispensary	220	110

Radio Station	290	160
Weather Station (N end of island)	280	110
Proj 6.6.Station (S end of island)	240	- -

In order to estimate the rate of decay between 8 and 11 March, the following radiation measurements were taken on three days on Rongelap Island:

	8 March	11 March
Central living area (village)	280 mr/hr	170 mr/hr
Southern most cistern	220 mr/hr	145 mr/hr
Roof of cistern (Southern most)	240 mr/hr	140 mr/hr
Ground (contact) cistern area	220 mr/hr	110 mr/hr

An area was selected 30 yards inland from the Rongelap cemetery as a measuring point for future decay measurements. This area is outlined with 2X4s plac. on pails. The waist height reading was 210 mr/hr at 1000 hours, 11 March 1954.

7. Sample collections

Water samples were collected from the water supplies of all inhabited areas. About two quarts of water were transferred to a polyethlene bottle at each site. These will be turned over to the New York Operations Office, AEC f analysis.

Soil samples were collected at all inhabited areas and also at several uninhabited islands. In collecting the soil samples a one foot by one foot square was marked on the ground and soil to about one inch of depth was removed from the square and transferred to a cardboard container. The primary samples will be turned over to the New York Operation Office, AEC, for analysis, and some smaller samples will be analyzed by Program 2 of TU 13.

Listed in Table 3 are the samples taken with the dose rate measured at waist height at the location where they were taken.

TABLE 3 - SOIL

Sample No.	Atoll	Island	Date	Mr/Hr
1*	Rongelap	Rongelap (North end)	8 Mar	440
2	Rongelap	Rongelap (Center of village)	8 Mar	280
3	Rongelap	Rongelap (1 mile north of village)	8 Mar	340
4	Rongelap	Rongelap (near South cistern of village)	8 Mar	220
5*	Rongelap	Eriirippu	8 Mar	2200
6*	Rongelap	Eniaetok	8 Mar	900
7*	Rongelap	Kabelle	8 Mar	2000
8*	Utirik	Utirik	9 Mar	40
9	Bikar	Bikar	9 Mar	160
10	Rongerik	Eniwetak	10 Mar	280
11*	Ailinginae	Sifo	10 Mar	100

*Small additional sample taken for analysis by Program 2 of TU 13.

6

TABLE 3 - WATER

Sample No.	Atoll	Island	Date	Mr/Hr
1	Rongelap	Rongelap (central cistern)	8 Mar	300
2	Rongelap	Rongelap (North part of village)	8 Mar	350
3	Rongelap	Rongelap (Northernmost cistern)	8 Mar	400
4	Rongelap	Rongelap (Southernmost cistern)	8 Mar	220
5	Utirik	Utirik (cistern near church)	9 Mar	40
6	Utirik	Utirik (cistern at south of village)	9 Mar	40
7	Rongerik	Eniwetak (Distillation water)	10 Mar	240

In addition to the above, a sample of foilage was taken at the windward side of Bikar Island. The radiation field was 180 mr/hr on 9 March 1954 at this point.

8. Conclusions and Recommendations

a. The radiological survey proved that a large yield surface detonation can produce extremely serious radiological contamination over a distance more than 120 miles downwind and important contamination about 250 miles downwind.

b. The center of the contamination pattern from the BRAVO Shot lies somewhat north of Rongelap and Rongerik Atolls and probably not far from a line between Bikini and Bikar.

c. Although the fall-out was serious on Rongelap Island located at the extreme southeast tip of the atoll, the contamination was about ten times greater at the north side of the atoll, twenty miles away.

d. The contamination decreased by a factor of about eight over the downwind distance of 50 miles between Rongelap and Rongerik.

e. Standard military field housing provides a significant degree of protection to personnel inside.

f. The AN/PDR-39 proved to be a very satisfactory instrument for field survey work under rigorous environmental conditions.

g. A single DDE with two (2) whale boats is not a completely satisfactory method of conducting a broad radiological survey of the type just completed. Future surveys should consider using vessels capable of entering more of the atolls and of handling a helicopter and several small boats.

6 Incls:
1. Rad. Survey Rongelap
2. Rad. Survey Utirik
3. Rad. Survey Bikar
4. Rad. Survey Rongerik
5. Rad. Survey Ailinginae
6. Summary of Rad. Survey

/s/ Herbert Scoville
DR. HERBERT SCOVILLE
Technical Director
AFSWP

5

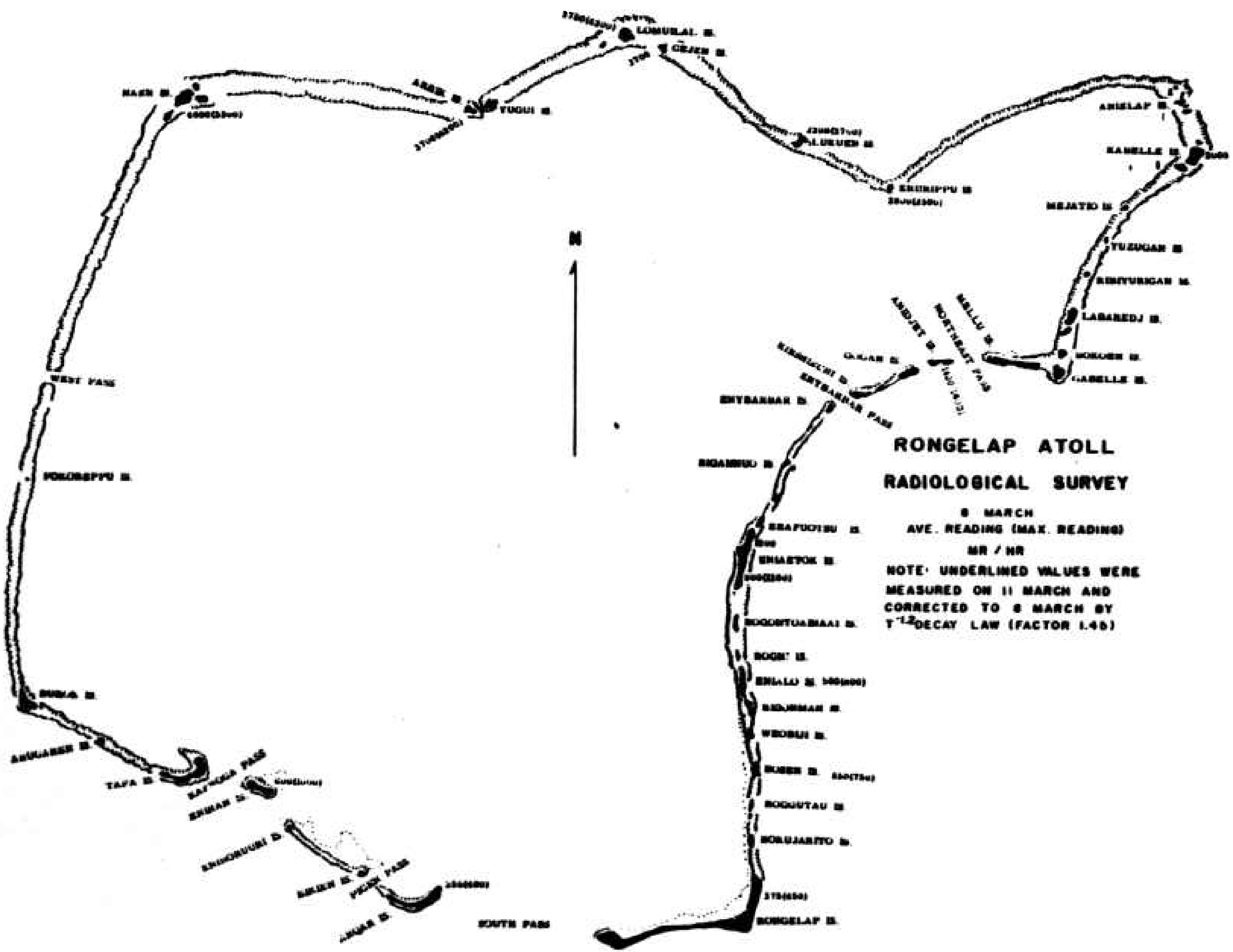
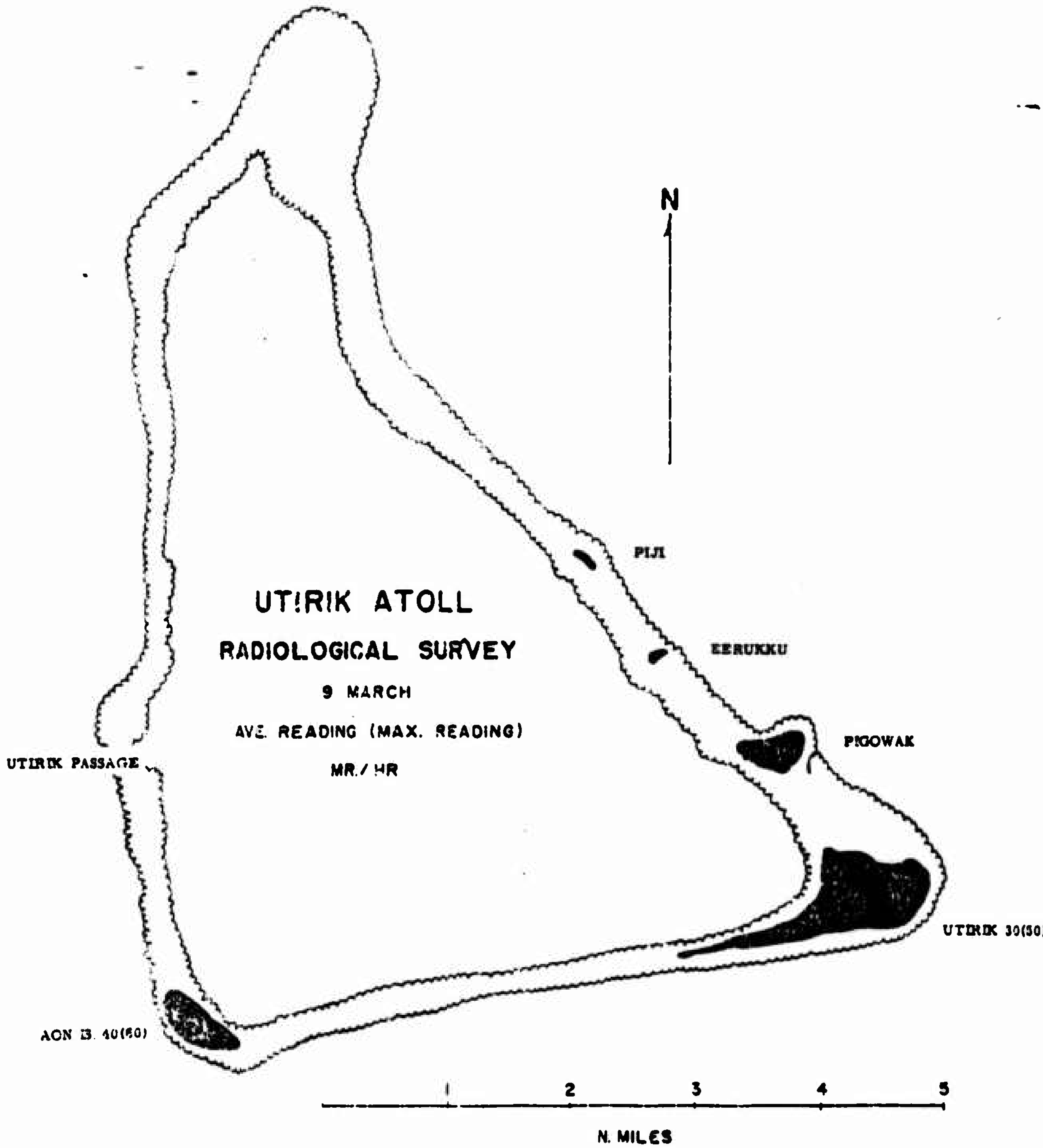

N
RONGELAP ATOLL
RADIOLOGICAL SURVEY
6 MARCH
AVE. READING (MAX. READING)
MR / HR
NOTE: UNDERLINED VALUES WERE
MEASURED ON 11 MARCH AND
CORRECTED TO 6 MARCH BY
$T^{-1.2}$ DECAY LAW (FACTOR 1.46)
LOMUILAL IS.
YUGUI IS.
ANIELAP IS.
KABELLE IS.
MEJATO IS.
TUZUGAN IS.
LABAREDJ IS.
GABELLE IS.
NORTHEAST PASS
ENYBARBAR PASS
WEST PASS
SOUTH PASS
RONGELAP IS.

FIG. I



N
PIJI
EERUKKU
PIGOWAK
UTIRIK ATOLL
RADIOLOGICAL SURVEY
9 MARCH
AVE. READING (MAX. READING)
MR./HR
UTIRIK PASSAGE
UTIRIK 30(50)
AON B. 40(60)
1
2
3
4
5
N. MILES

FIG. 2

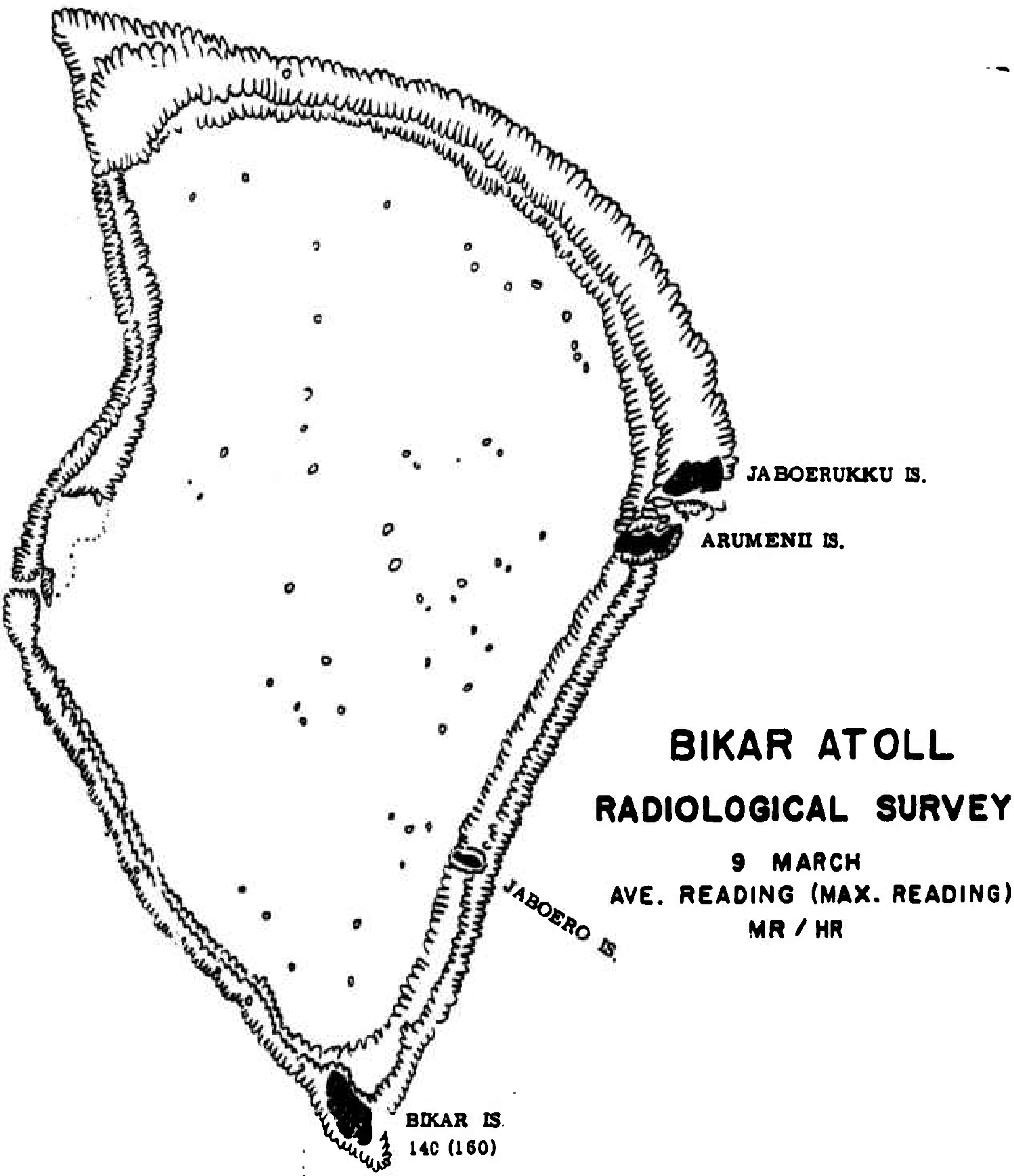
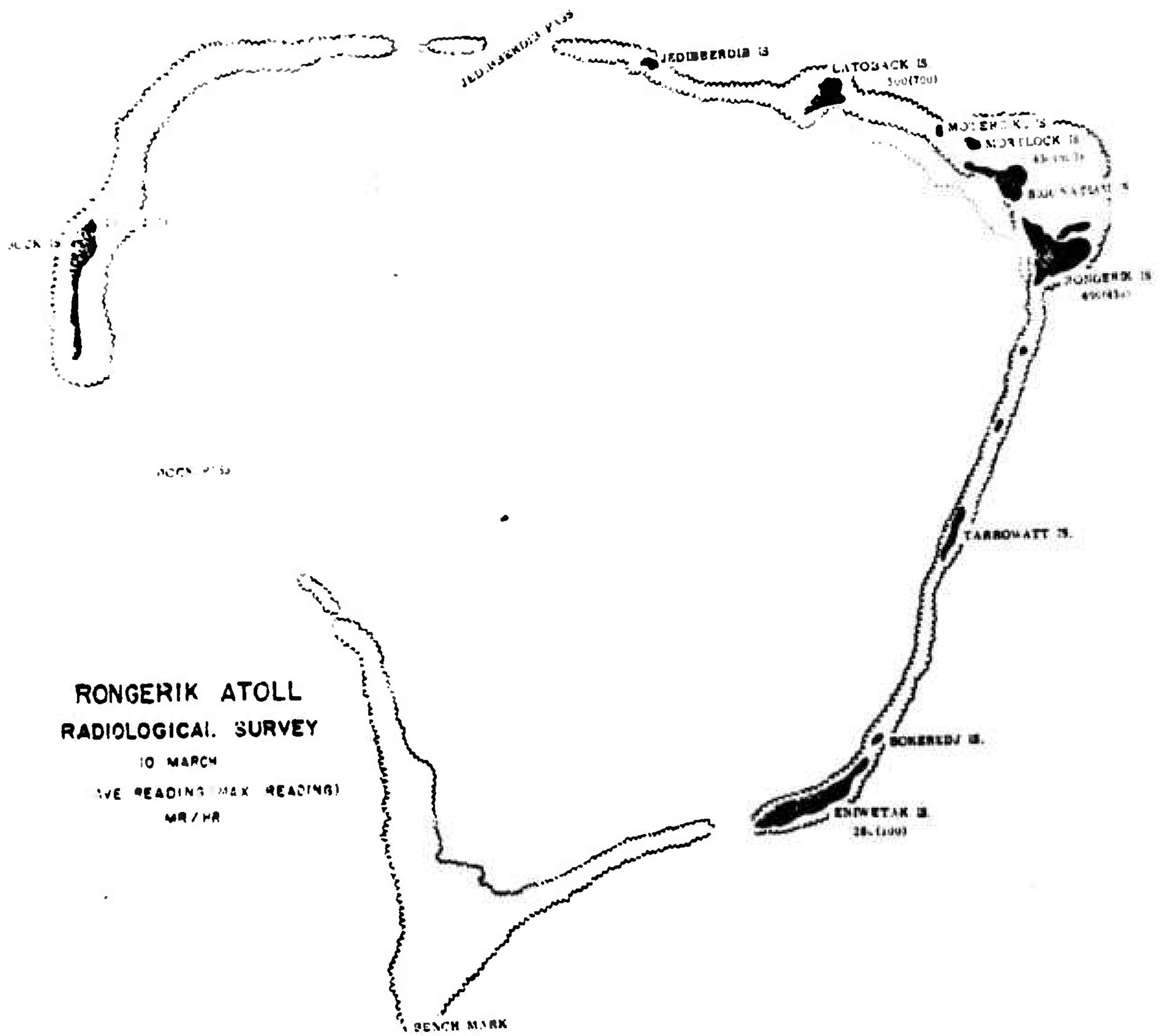

JABOERUKKU IS.
ARUMENII IS.
JABOERO IS.
BIKAR IS.
140 (160)
BIKAR ATOLL
RADIOLOGICAL SURVEY
9 MARCH
AVE. READING (MAX. READING)
MR / HR

FIG. 3



RONGERIK ATOLL
RADIOLOGICAL SURVEY
10 MARCH
(AVE READING (MAX READING)
MR/HR

FIG. 4

AILINGINAE ATOLL

RADIOLOGICAL SURVEY

10 MARCH

AVERAGE READING (MAX READING)
MR/HR.

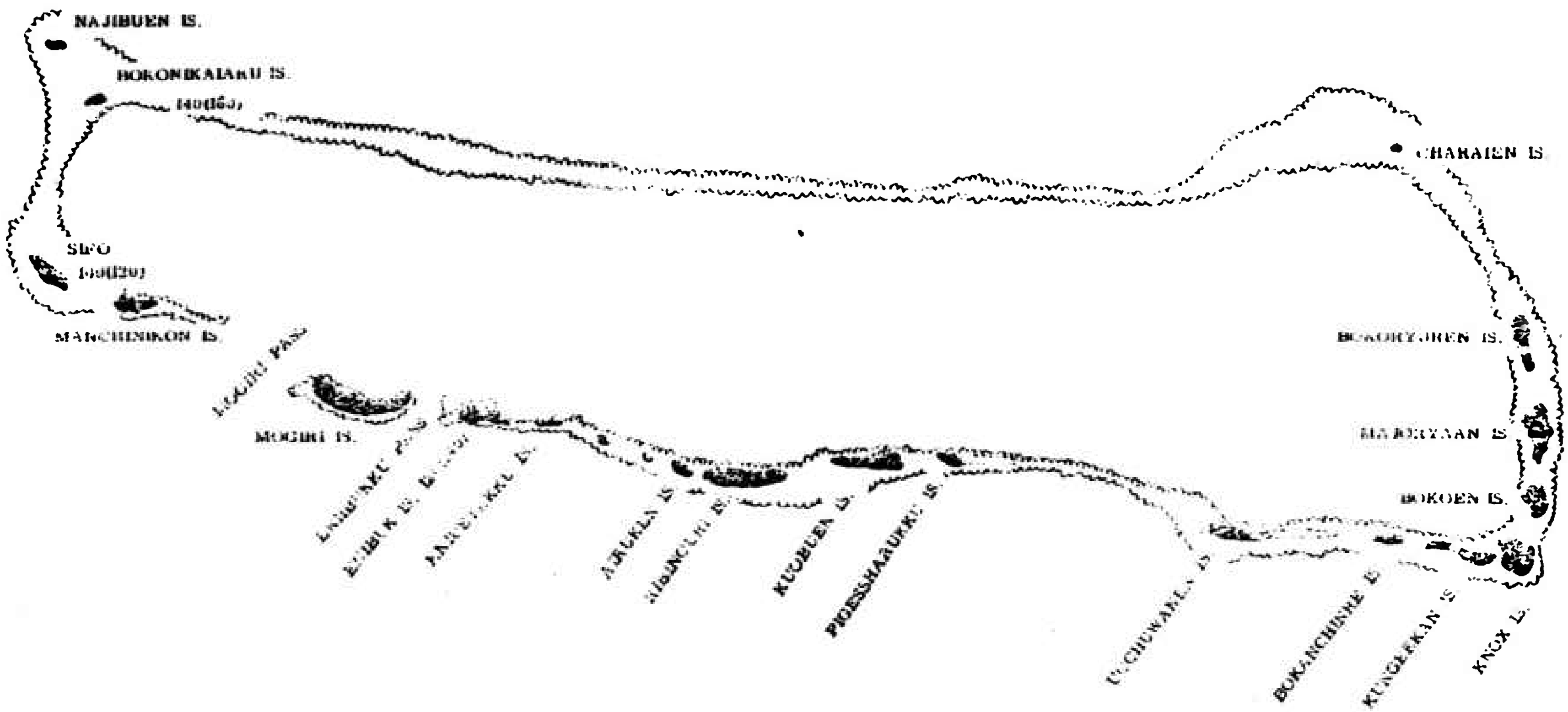


FIG. 5

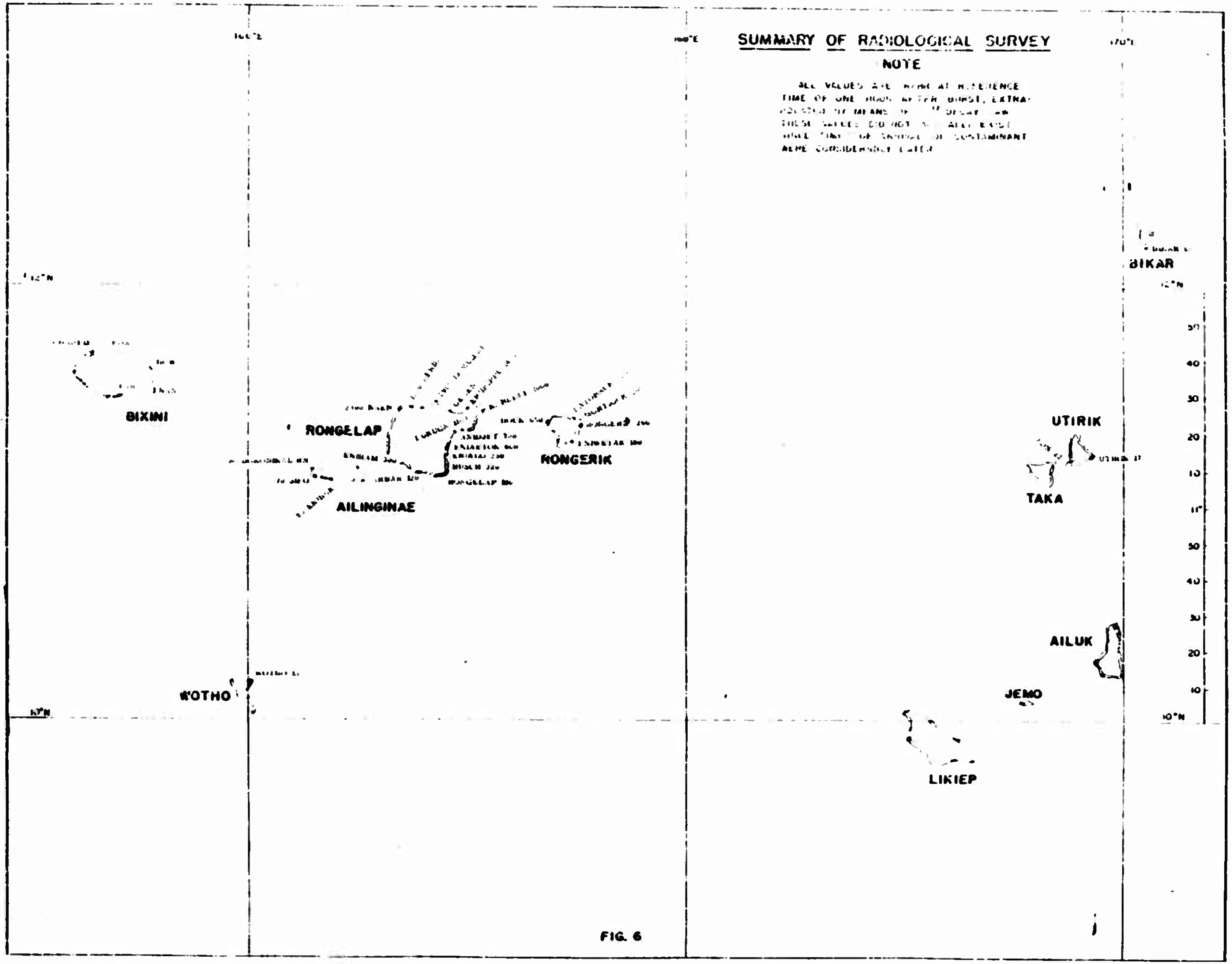

SUMMARY OF RADIOLOGICAL SURVEY
NOTE
BIXINI
RONGELAP
AILINGINAE
RONGERIK
WOTHO
UTIRIK
TAKA
BIKAR
AILUK
JEMO
LIKIEP

FIG. 6

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW) c/o PM
San Francisco, Calif.

J-3/370.05 9 April 1954

SUBJECT: Reports on Evacuation of Natives and Surveys of Several Marshall Island Atolls

TO: See Distribution

1. Reference is made to letter this headquarters, J-3/729.3, subject: Radiological Surveys of Several Marshall Island Atolls, dated 18 March 1954 (Secret, Restricted Data).

2. Attached herewith for your information and retention are copies of additional reports and memoranda pertaining to the above reference.

3. In addition to the above material, motion picture and still photography was accomplished on various phases of the initial pre-evacuation surveys and on the reception of natives at Kwajalein. Contact black and white prints of the still photography are being prepared as further material to document the native evacuation effort. These prints will not be of professional quality and will be forwarded primarily to indicate the over-all photographic coverage. Distribution will be made approximately 30 April 1954, availability of prints permitting distribution to the following only: C/S USA (ExAgt), DMA (AEC), DBM (AEC), HICOMTERPACIS, CINCPAC, CINCPACFLT, ChAFSWP, COMNAVSTAKWAJ. Additional prints in specific sizes and quality, and motion picture coverage, may be procured in accordance with Annex T to CJTF SEVEN Operation Order 3-53. Particular attention is invited to paragraph 2b, Annex T covering Distribution and Control of photographic materials by the Atomic Energy Commission and the Department of Defense.

P. W. Clarkson

P. W. CLARKSON
Major General, USA
Commander

DISTRIBUTION:
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HICOMTERPACIS (1 cy)
COMNAVSTAKWAJ (1 cy)
DMA/AEC (1 cy)
DBM/AEC (1 cy)
Ch AFSWP (1 cy)
CG FldComd (DWET) (1 cy)
C/S USA, ExAgt (1 cy)
LASL H Div (1 cy)
HASL, NYOO (c/o Mgr Opns) (2 cys)
USS RENSHAW (DDE-499) (1 cy)
USS PHILIP (DDE-498) (1 cy)
USS NICHOLAS (DDE-449) (1 cy)

9 Incls:
1. Report by CO USS PHILIP, Ser 001, subj: Evacuation of Rongelap and Ailinginae Atolls on 3 Mar 54, dtd 5 Mar 54.
2. Report by CO USS RENSHAW, Ser 038, subj: Report of Evacuation of Natives, Utirik Atoll, 4 Mar 54, dtd 18 Mar 1954.
3. Report by CO USS NICHOLAS, (and 1st Ind by CTG 7.3, Ser 0698 dtd 25 Mar 54), basic ltr ser 049, subj: Radsafe Survey 8-11 Mar 54, dtd 20 Mar 54.
4. Report by CO USS NICHOLAS, Ser 054, subj: Report of Rongelap Survey Trip, 25-26 Mar 54, dtd 2? Mar 54.
5. Memo for CJTF SEVEN, subj: DDE Trip to Rongelap Atoll 26 Mar 54, dtd 30 Mar 54.
6. M/R: Miscellaneous Radsafe Surveys of Rongerik.
7. M/R: Kwajalein NYOO Flight ABLE Results.
8. Drinking Water Samples (Analysis Report).
9. Soil Samples (Analysis Report).

£ 14-19

USS PHILIP (DDE 498)
Care of Fleet Post Office
San Francisco, California

DDE498:VLM:GWA:wk
H2-1
Serial: 001

5 Mar 1954

From: Commanding Officer
To: Commander, Task Group 7.3

Subj: Evacuation of Rongelap and Ailinginae Atolls on 3 March 1954; report of

Ref: (a) COMTASKGROUP 7.3 Disp 020848Z of March 1954
(b) COM JTF SEVEN Disp 021225Z of March 1954

Encl: (1) Passenger lists of evacuees from Rongelap and Ailinginae Atoll
(2) Radiological statistics reported by monitor teams, Rongelap and Ailinginae Atolls
(3) Location of water cisterns, Rongelap Island

1. In compliance with reference (a), the PHILIP got underway from Bikini at 2145M on 2 March and arrived and anchored off Rongelap Island in the lagoon at 0730M on 3 March. A PBM-5A (VP-29) aircraft, No. 2085, piloted by LCDR WELCH which previously had been dispatched from Kwajalein anchored about 100 yards off the beach of the same island shortly before the PHILIP anchored. Prior to anchoring, the PBM, in good radio communication with the PHILIP, made a thorough reconnaissance flight around the atoll. Also on departure the previous evening, the Commanding Officer of the PC 1546 offered much valuable navigational and general information which was of great help to the PHILIP.

2. The beach party including the Commanding Officer, Executive Officer, Radiological Safety Officer and a three man monitoring team proceeded from the PHILIP in a motor whale-boat to the PBM and picked up Mr. Marion WILDS, civilian representative of the Civil Administration Unit, Marshalls Trust Territories of Pacific Islands, and Oscar DeBrum, Marshallese interpreter. The beach was such as to allow an easy close-in landing without danger to the boat.

3. The party was met at the beach by John, the Magistrate of Rongelap. Monitoring of the island commenced immediately. On the basis of initial readings it appeared obvious that evacuation was definitely in order. The Commanding Officer, U.S.S. PHILIP presented Mr. Wilds with the general picture based on monitoring information, and on being informed that Commander Joint Task Force SEVEN had stated that the actual evacuation should be requested by trust territory officials, Mr. Wilds was very emphatic regarding the need for evacuation. Through the interpreter

X H-20

ENCLOSURE (1)

it was explained that it was to the best interests of the Rongelap people to leave the atoll and that the PHILIP was there for that purpose. Mr. Wilds was present during all the conversation with John the Magistrate and was of much assistance as also was LCDR V. L. MURTHA, Executive Officer of the PHILIP whose Majuro Island Government background proved very helpful in convincing the Marshallese that they should leave.

4. The information that the people would leave Rongelap was passed very quickly. Each person was asked to bring a small handbag as the only baggage since the monitors readings indicated a high dosage on sleeping mats, palm baskets, and other personal belongings. It is considered very important that once the accepted leader is established and identified that all requests be made through him without exception. This procedure expedited the entire operation.

5. It was decided to utilize the PBM to transport the elderly and the sick to Kwajalein. John designated sixteen (16) persons and this party was embarked in the aircraft in about an hour and a half after the party first landed. These passengers are listed in Enclosure (1) which is forwarded herewith.

6. Fortunately, the Marshallese were not reluctant to leave the island. The magistrate explained that the people had been sick and he obviously deduced that all of the people would soon be provided the necessary medical care. John was apprehensive about the safety of his boat, a 30 foot sloop. The sloop was towed by the ship's whale boat to a better lee. Two anchors were dropped and the boat appeared to be in good holding ground.

7. The forty eight (48) remaining Marshallese were transported via two ship's whale boats to the PHILIP. Names of evacuees are listed in enclosure (1).

8. De-contamination of the Marshallese commenced immediately upon embarkation. Routes had been previously established and the de-contamination teams on station ready to guide the passengers to the de-contamination center (after crew's washroom). Clothing was placed in two G.I. cans aft and after a thorough shower clean clothes were readily available at the exit. The crew donated sufficient white and dungaree trousers, dungaree and "T" shirts without which the de-contamination could not have been as effective.

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9. Women and children were billeted in the torpedo room and the men provided temporary shelter under a canvas tarpaulin rigged on the 01 level between the stacks. Cots were available as seats in both locations. The after officer's head and washroom, a short distance from the torpedo room was designated for use by the women and children. The men had the use of the after crew's head and washroom. The separation of the Marshallese was mandatory due to the limited space available in the torpedo room. A continuous 24 hour sentry watch, all petty officers, was set at both locations to insure privacy and to assist in any requests made by the Marshallese.

10. All children were provided milk shortly after de-contamination. The Marshallese went through the regular mess line for meals and had the same ration as the crew. The meat course was the least popular. The majority of the party asked for more soup, bread and vegetables. Hot soup was most in demand. Ice cream was the natural favorite of all the children.

11. The contaminated clothing was washed in the ship's laundry with a strong soap solution, dried, pressed and returned within four hours after the party embarked.

12. Sleeping accommodations, although crowded, were considered adequate. Twelve (12) cots and two (2) stretchers were set up in the torpedo room and the remaining deck space covered with kapok life jackets. The men slept on the fantail under the deck awning. Life jackets proved to be comfortable pallets and are excellent insulation against warm or damp decks. With the above arrangements each person had a sleeping space.

13. The P3M plane Commander reported that he thought he saw some people on Eniaetok Island (Rongelap Atoll). A party, including John and Oscar DeBrum, the interpreter, landed on this island at 031245M. A thorough search was made but no Marshallese were located. The Magistrate insured the search party that he was certain that there were no persons there since a boat was not nearby. Monitor team readings indicated an average of 3.02 Roentgens, with a maximum reading of 3.65 Roentgens. Monitor team statistics are included in enclosure (2). It was lucky that this island was not inhabited.

14. Six (6) samples of water taken from wells on Rongelap have been forwarded in compliance with reference (b). Approximate locations of wells are indicated in enclosure (3).

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5 Mar 1954

15. The ship then proceeded to Ailinginae Atoll. The Magistrate believed it possible that a party was on Enibuk Island. A party was landed, conducted a thorough search but found no one. The ship remained in the vicinity of Enibuk while the two whale boats proceeded to Sifo Island. A sloop was sighted anchored in the lagoon off Sifo Island. The party landed and John the Magistrate once again explained the need for leaving Rongelap. Eighteen (18) Marshallese were transported from this island. Both this group, and John, assured the party that there were no Marshallese on any of the other islands and the evacuation was considered completed. The sloop was anchored off the island in a good lee. The same procedures for handling the 18 evacuees from Sifo were followed as described in the proceeding paragraphs.

16. The PHILIP departed from Ailinginae at 1800M on 3 March and arrived at the Naval Station Kwajalein at 0830M on 4 March. The Marshallese were disembarked during the morning of 4 March and removed to the Naval Dispensary. On arrival, the PHILIP was visited by Commander, Naval Station, Kwajalein, and representatives of Commander Joint Task Force SEVEN.

17. In spite of the willingness of the people to leave their homes there was understandable concern over the safety of the two sloops left behind at Rongelap and Sifo. These boats are a community asset for hauling copra and returning the basic food staples, medicines and clothing during the period that Trust Territory field trip ships are not available. There was a considerable amount of copra in a drying shed on Eniaetok and a smaller amount on Sifo. It was most disheartening to the Magistrate to leave the copra behind since he himself had prepared the copra on Eniaetok last week. All livestock, including about one hundred chickens and ten pigs were abandoned on Rongelap. Two dogs were also left on the island. Since the people were not given an estimate of the duration of their evacuation, the concern over the above items will no doubt increase as the absence from their homes grows longer.

18. It is recommended that aircraft periodically check the condition of the two sloops at Rongelap and Sifo. It is further recommended that some consideration be given to the transfer of livestock, copra and personal belongings on Rongelap, Sifo, Eniaetok. There is a possibility that these animals could be of much value for scientific research.

19. The Marshallese were excellent passengers, most cooperative, never demanding and exemplary in conduct. It was a distinct pleasure for the crew of the PHILIP to have been afforded the opportunity to assist these quiet people in the evacuation.

Copy to:
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CJTF SEVEN
CTU 7.3.1
CTG 7.1

H-23

G. W. ALBIN

A LIST OF MARSHALLESE EVACUATED VIA PBM FROM RONGELAP ISLAND ON 3 MARCH 1954

	NAME	SEX	AGE
1.	Loman	Male	66
2.	Kanena	Male	75
3.	Luiar	Female	83
4.	Jelen	Male	70
5.	Koma	Female	63
6.	Tibaj	Male	28
7.	Bekiri	Female	62
8.	Jenet	Female	52
9.	Betty	Female	6
10.	Rinok	Female	17
11.	Almira	Female	19
12.	Ellin	Female	24
13.	Luwetak	Female	78
14.	Jabwe	Male	30
15.	Antak	Male	48
16.	Anjar	Female	59

H - 24

A LIST OF MARSHALLESE EMBARKED ABOARD THE USS PHILIP (DDE 498) FROM RONGELAP ISLAND ON 3 MARCH 1954

	NAME	SEX	AGE
1.	Naptali	Male	49
2.	Fkuiak	Male	43
3.	Bella	Male	37
4.	Hainrick	Male	36
5.	Zitikos	Male	44
6.	John	Male	31
7.	Beaj	Male	30
8.	Jia	Male	20
9.	Jerkan	Male	15
10.	Nario	Male	12
11.	Kitnar	Male	7
12.	Sakraias	Male	7
13.	Herry	Male	6
14.	Elio	Male	5
15.	Jeban	Male	4
16.	Iroji	Male	13
17.	Zinier	Male	2
18.	Alet	Male	2
19.	Dejen	Male	2
20.	Lakij	Male	1
21.	Dik	Male	2
22.	Joj	Male	4
23.	Kiuaja	Female	59
24.	Marta	Female	53
25.	Jedra	Female	50
26.	Mwenarihi	Female	38
27.	Zila	Female	37
28.	Nejak	Female	31
29.	Mina	Female	30
30.	Mitswa	Female	28
31.	Muje	Female	26
32.	Rekko	Female	12
33.	Zatak	Male	60
34.	Zije	Female	4
35.	Mina	Female	2
36.	Nerje	Female	7
37.	Hetsi	Female	18
38.	Jimaco	Female	15
39.	Hruko	Female	15
40.	Mweo	Female	13
41.	Marry	Female	9
42.	Kaiki	Female	3
43.	Jonita	Female	4
44.	Ermita	Female	3
45.	Jemlik	Female	2
46.	Kiojan	Female	15
47.	Niktimos	Male	20
48.	Biliet	Male	33

A LIST OF MARSHALLESE EMBARKED ABOARD THE USS PHILIP (DDE 498) FROM SIFO ISLAND ON 3 MARCH 1954

	NAME	SEX	AGE
1.	Jojea	Male	35
2.	Baul	Male	2
3.	Jaken	Male	42
4.	Kotea	Male	4
5.	Janoor	Male	57
6.	Torty	Female	55
7.	Apea	Female	13
8.	Jonbok	Female	10
9.	Jabkeon	Female	1
10.	Kaban	Female	19
11.	Bolking	Female	2
12.	Biliem	Female	12
13.	Nameko	Female	16
14.	John	Female	2
15.	Katy	Female	16
16.	Lija	Female	37
17.	Amon	Female	25
18.	Kajim	Female	35

RAD SAFE REPORT

(Evacuation and Decontamination of Marshallese Natives)

I. Data:

	Island	READINGS (in MR/HR) Ave.	Max.	Inhabited	Time of Readings
RONGELAP ATOLL	Rongelap	1473	1900	Yes	031045M
RONGELAP ATOLL	Eniaetok	3039	3650	No	031245M
AILINGINAE ATOLL	Enibuk	445	550	No	031545M
AILINGINAE ATOLL	Sifo	412	480	Yes	031715M
Totals	4	- - - - - - - - - - -		2	- - - -

II. DECONTAMINATION: (PERSONNEL)

1. Decontamination readings are as follows:

Average Readings

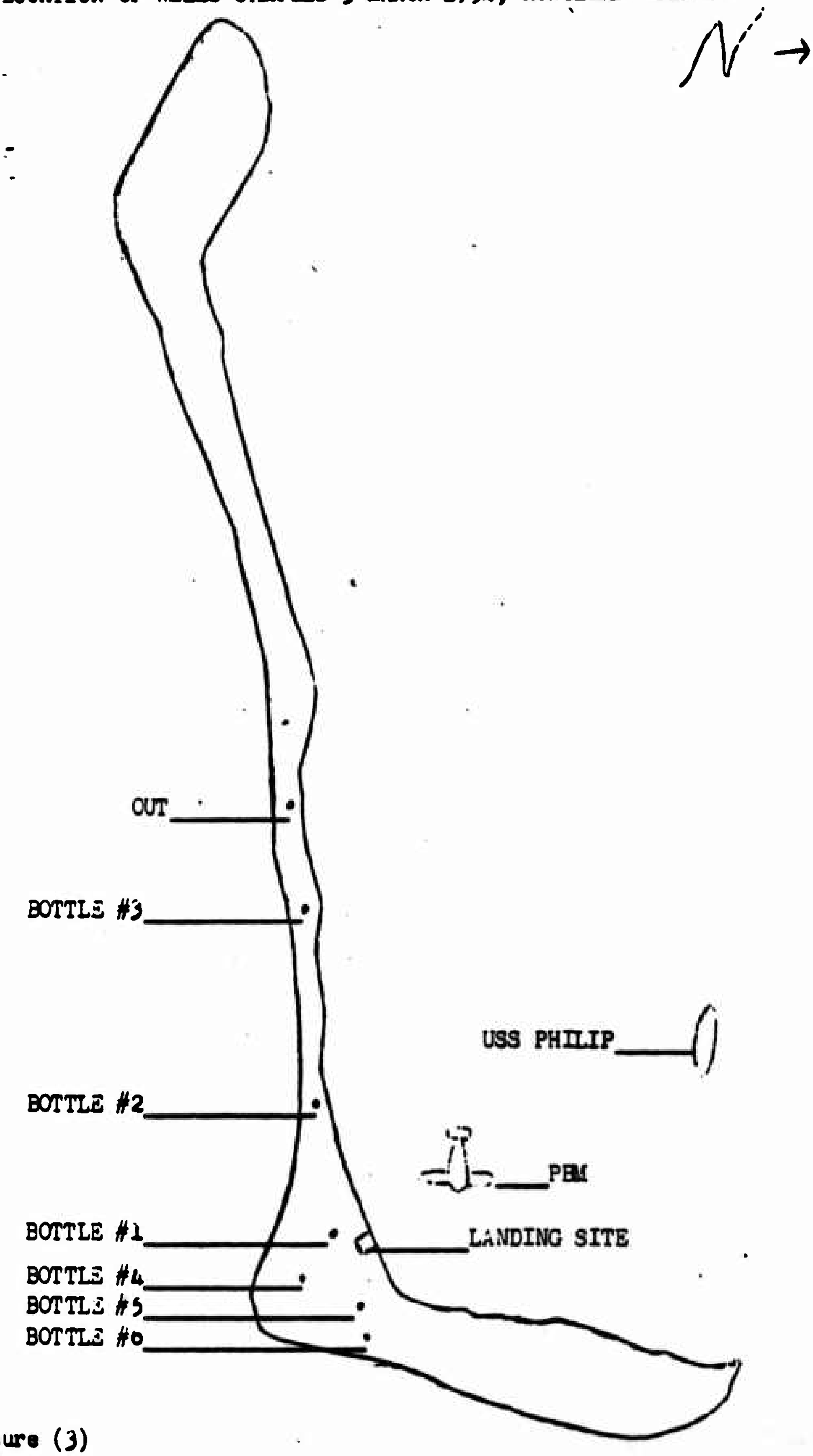
ISLAND	Before Decontamination	After Decontamination
Rongelap	60 MR/HR	25 MR/HR
Sifo	40 MR/HR	15 MR/HR

NOTE #1. Clothing was slightly contaminated even after decontaminating procedures were employed due to its rough surface and prolonged exposure to radiation. However, maximum readings of less than 50 MR/HR did not warrant discarding women's clothing due to the short time it was to be worn.

NOTE #2. Decontamination upon leaving the ship: 20-22 MR/HR.

Enclosure (2)

LOCATION OF WELLS SAMPLED 3 MARCH 1954, RONGELAP ISLAND.



Enclosure (3)

USS RENSHAW (DDE-499)
%Fleet Post Office
San Francisco, California

In Reply Refer to
DDE499/LHA:rec
A9
Serial: 038
18 March 1954

From: Commanding Officer, U.S.S. RENSHAW (DDE-499)
To: Commander Task Group SEVEN POINT THREE

Subj: Report of Evacuation of Natives, Utirik Atoll, 4 March 1954

Ref: (a) CTG 7.3 conf disp 031220Z
(b) CTG 7.3 conf disp 032040Z

Encl: (1) Informal Narrative of Evacuation of Utirik Island Natives

1. In accordance with reference (b), enclosure (1) is submitted herewith.

2. A limited number of photographs were taken of some phases of the evacuation by the ship's official photographer. These are not being processed and it is later planned to submit prints as a supplement to this report.

3. The four drinking water samples mentioned in enclosure (1) as obtained from the regular living area, Utirik, were delivered to CJTF 7 on 8 March 1954 via Major R. D. Crea, USA, Staff CJTF 7.

/s/
L. H. ALFORD

Copy to:
CTU 7.3.1

ENCLOSURE (2)

Enclosure (2)
to CTG 7.3 ltr
Serial 0691

INFORMAL NARRATIVE OF EVACUATION OF NATIVES FROM

UTIRIK ATOLL, MARSHALL ISLANDS

Having received orders at just before dawn on 3 March 1954, to proceed to Utirik Atoll, the Renshaw, immediately departed from the patrol area north of Eniwetok Atoll and set course eastward to pass south of Bikini enroute. Speed was adjusted to arrive at daylight the next day and the 400 mile voyage was completed without incident.

Meanwhile, new activity was evident in Renshaw. Charts, sailing directions, tide tables and all possible sources of information on the Atoll were searched and avidly studied. Although the decision that the natives would be evacuated was not known on board until late in the night of the 3rd, plans were firmed up for handling the people. Several schemes were put forward but the final plan was made with the invaluable knowledge and assistance of E. K. Tryba, BMC, USN. He had served a tour of duty in trust territories west of the Marshalls and had experience in evacuation of natives.

Although the Douglas A. Munro (DE-422) was detailed to assist Renshaw, her estimated arrival was not until 041330M, hence plans were made for the possibility of receiving on board Renshaw all the reported 180 natives of the Atoll.

The approach to the target Atoll was made from the westward and north of Taka Atoll which is only 4 miles SW of Utirik. It was sighted at about 0630M on the morning of 4 March and course was set southeastward to pass between the two atolls. Enroute to the south side of triangular shaped Utirik Atoll, we passed close to the reef on the western side in order to get a look at Utirik Passage. There was no thought of entering this channel inasmuch as Sailing Directions were very definite that no ship larger than a PC should make the attempt. Nevertheless, a look was desired to determine if charted beacons were present (they weren't) and to determine the feasibility of our boats entering the lagoon or perhaps even the DE should it be found too dangerous on the south side for the evacuation. Theoretically, it would have even been possible for Renshaw to enter at high tide about 1600M when our 18 ft. drag aft would clear the channel about 3 ft. if the charted depths were correct and if the sun at our backs made the channel and coral heads visible. It was reckoned that the thrill of entering this channel for the C.O. would be about like that of Russian roulette.

Upon rounding the SW tip of the Atoll, course was set eastward to skirt the reef along the southern leg which appeared to offer the best lee from wind and surf for the evacuation. Fortunately the weather was exceptionally good with light NE winds and only moderate swells. At 0735M the ship hove to at about 500 yds just south of Utirik Is., the largest of the Atoll and on which all the natives were reported to live. At this time trust territory officials and interpreters had not arrived nor had an ETA been received. In view of our directive to commence evacuation at daylight it was decided

to proceed at once as best we could until the trust officials arrived or if necessary without them. It was hoped that we might find a missionary, a pidgin English native or even a trust representative ashore.

Consequently at about 0740 the gig (26 ft. MWB) was launched and a beach party was embarked with the Executive Officer, LCDR W. R. Easton, USN, in charge. He was to try to get ashore as soon as possible, organize the natives for evacuation and determine the best location and means for the evacuation. Included in this party were the Radsafe Officer, monitor, hospitalman, signalman, etc. As soon as this party shoved off, a second MWB was launched with the Gunnery Officer in charge, who was to search along the reef for a break or a more favorable spot for safe boat handling in the evacuation.

Now, as the boats left the ship, we commenced execution of our plans for receiving the natives on board. Awnings were rigged on the fantail with side strips from the deck to the redge ropes. Additional life lines were rigged for the safety of children. Fore and aft and vertical accesses to the fantail were closed or roped off and awnings rigged where necessary to ensure privacy for the natives. The entire crew's washroom and head aft (largest on board) were set aside for the natives and for their decontamination inasmuch as this is the ship's main station for this purpose. An outside salt water shower was rigged, a receptacle was provided for their clothes and sufficient clean dungaree shirts, trousers, etc., were raised by an appeal to the crew, to thus clothe all the natives. A pig-pen was fashioned by closing off access to a 3" gun tub. We planned to tether chickens to life lines on the 01 deck and let the dogs roam free amongst the populace.

Meanwhile, the Executive Officer and party approached the south shore of the island at a point about 1500 yds west of the eastern tip. The island here and elsewhere has a continuous outer perimeter of table reefs extending some 40 yds out into the water over which the waves produced a surf of medium size and presented considerable small boat hazard. Having selected a point where the surf was slight and appeared to offer the best spot, the Executive Officer commenced paddling ashore in a small, one-man rubber raft (we kept it after picking up a bailed-out jet pilot last fall), which had a line attached to it from the boat. After some progress towards the beach he appeared to experience difficulty with the surf and some unseen force resulting in no progress. Considerable humor and some concern were evoked at sight of the Executive Officer furiously paddling, each stroke whirling the raft 180° around but making no progress. It was later determined that the line from boat to the raft had fouled in the coral, securely anchoring him to seaward. By this time a few of the natives had appeared and some of them swam out and helped him ashore amidst friendly greetings.

At about this time, Navy JRF 912 seaplane arrived from Kwajalein, landed in the western part of the lagoon and commenced taxiing eastward towards

Utirik Is. - After establishing radio communications with the plane and ascertaining the number of passengers, the Executive Officer was directed to cross over to the lagoon side and use the rubber raft or any means to land the plane passengers. With the friendly help of the cooperative natives, the X.O. with the rubber raft, set out in an outrigger canoe towards the seaplane in the lagoon. But just as he approached the plane it taxiied away apparently not distinguishing him among the natives. It had been suggested to the plane that if he had difficulty landing passengers in the lagoon, he might try landing outside the lagoon near the ship. Upon hearing this suggestion, the plane took off immediately and after one try, a tremendous bounce, another circle and approach, landed near the ship about 0915M.

Meanwhile, the gig having disembarked the Executive Officer was instructed by him to proceed eastward about 500 yards to a small cove where the natives said landings could be made with more ease and safety. This was done but calling it a cove is a misuse of the term. Ease and safety did not seem to fit the situation either but it did appear less dangerous. By using the anchor to seaward the gig was slowly worked up to the reef edge where the Radsafe Officer and his team disembarked and waded ashore to the same friendly welcome, handshakes and "Good Morning" from every native large and small. During this time the Executive Officer had returned to the beach from the lagoon and his try at receiving the plane passengers and advised the native chief to prepare his people for evacuation. Some of the natives who seemed to understand and spoke some broken English were of great assistance in this. At this time the ship was advised by the X.O. of the necessity for evacuation on southern and seaward side of Utirik Island and that native boats would be of no practical assistance. The Gunnery Officer in the MWB, after searching for several miles along the south leg of the atoll, reported there were no breaks in the reef nor landing places of any kind.

After the gig had disembarked the remainder of the beach party, it was returned to the ship having lost its anchor in leaving the reef. It arrived in the vicinity of the ship just in time to meet the plane and take aboard its passengers. They consisted of Marshall Island Trust Territory representative, Marshall Island interpreter, and two public relations civilians attached to staff, CJTF 7. After a brief consultation on board and procurement of another boat anchor, the gig was again dispatched to the beach, meeting the MWB enroute and receiving from it a radioman with a portable SCR-300 radio which greatly facilitated the operation. This party was met by the Executive Officer and the group then set out for the village. The seaplane departed shortly for Kwajalein.

While this was going on the Radsafe Officer and his team were making their survey with radiac instruments AN/PDR-27E. The first readings taken were on the seaward side of the island where intensities of 110 mr (with and without beta shield) were found. Readings of 120-130 mr (with and without shield) were indicated along the foot path connecting the seaward side of the island to the village on the lagoon side. Upon arrival at the village, several natives were monitored with the following readings common to all; over all body 100 mr (with and without shield), hands 100 mr (with and without shield), gonads 105 mr with shield and 110 mr without shield, feet 115 mr with shield and 120 mr without shield. Since the readings in the air over the entire middle section of the island was 100 mr, it is believed that the 100 mr readings stated in this report were due to background intensity effects.

Other items monitored in the village and their intensities were; thatched roofs 125 mr with shield, 130 mr without shield, 4 water samples from wells 100 mr with and without shield, all food with exception of coconuts 100 mr with andwithout shield, coconuts in their various forms of preparation ranged from 130-150 without shield, fish cleaning table 124 mr with shield, 130 mr without shield. A short field trip was made into the undergrowth and grass areas surrounding the village where readings of 160 mr with shield, 170 mr without shield, were found close to the ground, indicating concentrated and trapped contaminating particles. The monitor made his way via projecting coral pieces some 10 yards into the lagoon where the water gave a 50 mr reading with and without the shield. The hospitalman was assigned the task of collecting water samples and succeeded in obtaining 4 samples of drinking water from 4 of the most commonly used cistern reservoirs in the village. It is believed that the very low contamination of the water was due to the roofs over each reservoir.

Upon arriving at the village the Executive Officer with Trust Territory official again informed the natives through the interpreter of the necessity for evacuation. The interpreter was asked not to scare the natives or unduly rush them. Nevertheless, he had the floor and after a few words, the natives really moved though it is not believed he shook them up too badly. It was carefully explained that we would take along their pigs, chickens, dogs, boats or anything we could load. But after a conference with the Trust official in which the degree of contamination, decay and ultimate return of the natives were discussed, it was decided, on recommendation of the official, to leave the livestock and boats behind. The natives agreed to this and after being reassured that their possessions and animals would be safe until their return, began streaming toward the evacuation beach. Possessions taken along rarely exceeded two bundles each, and one of which was usually a woven bedding mat.

At this time, about 1015M, the ship was advised by the X.O. that the evacuation would commence about 1100 and a life raft was requested for use in shuttling the natives over the reef and through the surf to the boats standing off about 50 yards. At approximately 1040M the boat arrived with the raft and the evacuation commenced at 1050. By this time the majority of the natives were gathered on the beach and ready to go. Women, children and old people were shuttled out to the boats first, with their possessions, followed by the men. Much cooperation and assistance were realized from the able native men whose alertness, willingness and ability to swim proved invaluable during the evacuation and reduced the number of ship's personnel required. At about 1200 the evacuation was about half completed but the wind was freshening, the tide was flooding and the surf was kicking up. The operation became increasingly hazardous and two raft loads of evacuees were very nearly upset in the surf. The coral was chewing up the suspension ropes and lattice work of the raft and in a radio consultation between the X.O. and C.O., serious consideration was given to ceasing the operation and trying again from the lagoon side. Since this would delay the operation several hours and also was fraught with danger as already indicated, and since we could see the end in sight, it was decided to continue. Most of the women, children and aged were already gone and no one had been hurt other than a few coral cuts. Another raft was dispatched and the paçe was stepped up, though less people were loaded on each raft and extreme care was exercised.

Ten LWB loads of about 15 people each were required to complete the evacuation of the 154 natives. The last raft load left the beach at about 1245M leaving as forlorn a set of dogs as you have ever seen. At 1251M all the natives were on board and none too soon because the wind and surf continued to increase. The native chief named Compass, has been repeatedly asked how many natives were on the atoll and if we had them all. He was insistent that all were on Utirik Island, none were on other islands of the atoll, and none were on Taka Atoll, 4 - 5 miles away. He first said there were 161 natives present and proudly brought out a card index file to prove it. Careful questioning however indicated that at least two infants had died a day or two before and that the old boy didn't have this PAMI records up to date. The next figure we got was 157 but further questioning indicated he was counting two or three imminent but as yet unborn babies. The last figure of 154 was arrived at after a count on board and was concurred in by the chief and Trust official. A breakdown was as follows: men 47, women 55, children under 16, boys and girls, 26 each.

At about 1300M when rafts were secured and boats were hoisted, course was set for Kwajalein to arrive at dawn on the 5th. At about 1345M we met the D.A. Munro (DE-422) coming up from Kwajalein to assist us but there was nothing further for her to do but fall in astern and return to Kwajalein.

H-34

It did not seem prudent to further move the natives around by dividing them up between the two ships, inasmuch as no great overcrowding was evident. The Munro had a medical officer on board and offered his services which fortunately were not needed. It was comforting to know he was available — however, should any of the pregnant women fall due and payable while on board.

Reception and handling of the natives on board worked out fairly well and generally as was expected. Each one was monitored as they came on board and readings were around 7 mr/hr which was substantially lower than the average of 20 mr/hr readings on the beach. This indicated that wading out to the rafts had helped quite a bit in reducing presence of fall-out material on feet and clothing. Some of the children were routed through the showers as soon as they came on board. But it was decided to feed all of them before starting decontamination of adults. Serving lines were set up on the fantail using regular steam table trays of food and giving the natives paper plates, cups, etc. They didn't eat very well, perhaps from the excitement or maybe they just don't like meat loaf. They did better on the bread, mashed potatoes and oranges.

After lunch the Trust Territory official made some suggestions for changing and improving our facilities which included careful partitioning and segregation of the women's side of the head and washrooms. He explained that under conditions of excitement and strange surroundings the women are extremely modest. Then commenced decontamination measures and considerable resistence was encountered. But by prodding and cajoling we managed to get all about 10% of them through the showers. These were the aged, infirm and sick. With no readings higher than 7 mr/hr it was decided not prudent to force the old people in the showers. Next the problem of clothing arose, We had sufficient clean dungarees for them all and planned to run all their clothes through the laundry and give them back to put on before leaving the ship. But here again stiff resistence was encountered. We tried but they couldn't seem to understand taking their clothes away and the women wanted no part of the dungarees. Clothes were monitored and since they averaged only about 3-4 mr/hr it was decided that the situation did not call for such drastic measures. All of these matters were discussed with the Trust Territory official, and decisions were concurred in or made on his recommendations. Careful observation of the natives and questioning of the interpreter as to their mood, excitement and general morale convinced us that forcing them to give up their clothes would really shake them up.

By late afternoon they were settled down on their mats and generally quiet except for the kids, some of whom took several showers. They were bright-eyed and cute as could be. Some few of the women, as is their wont, talked quietly but steadily all afternoon from the time they came aboard.

We fixed up a fine supper for them of boiled fish and rice with tomatoes and Lima beans mixed in. By this time they had gotten used to their surroundings, had recovered their composure and their appetites. They really stowed away the chow. This was followed by ice cream and cookies, heavily sweetened grape ade and some bright colored hard candy we had left over from last Christmas. The men were given cigarettes and all seemed contented and happy. Finally, we showed them a movie and there was not the slightest reaction of any kind from any of them the whole time. It should be remembered that most of these natives had never been off the atoll and as far as is known had never seen a movie.

The night was passed without incident and they seemed to rest well on their straw mats. The weather continued good and since we were proceeding downwind at a speed of only 11 knots there was practically no motion of the ship. Next morning they ate and seemed to enjoy a big breakfast of hot cakes, bacon, bread and jam. After considerable rubber necking as we entered Kwajalein harbor and during the process of mooring to the pier, the natives were disembarked at about 050900M to waiting buses in custody of ComNavStaKwaj. As they went over the side one could not help but observe and admire the innate dignity of these simple human beings and their naive but forthright and optimistic attitude towards life. These seemed to be expressed in a conversation with the native chief through the interpreter. The chief was asked what they had seen and he replied with gestures indicating a large explosion. He was then asked what they thought of it and his reply was not the negative one as might be expected that the world was coming to an end, but, "The world, we think she start over again."

JOINT TASK FORCE SEVEN
TASK GROUP 7.3
APO 187 (HOW), c/o Postmaster
San Francisco, California

FF3/7.3/10:jmt
A16-10
Ser: 0698
25 Mar 1954

FIRST ENDORSEMENT ON USS NICHOLAS (DDE-449) ltr P-22 ser 049 of 20 Mar 54

From: Commander, Task Group 7.3
To: Commander in Chief, Pacific
Via: Commander, Joint Task Force SEVEN

Subj: RadSafe Survey 8-11 March 1954

1. Forwarded as a matter of information.

2. The recommendations of the Commanding Officer, USS NICHOLAS (DDE-449), will be considered carefully if additional surveys of this type are required.

H. C. BRUTON

Copy to:
CTG 7.1
COMCORTDESDIV 12 (without basic)
USS NICHOLAS (DDE-449) (without basic)

INCLOSURE (3)

USS NICHOLAS(DDE-449)
Fleet Post Office
San Francisco, California

DDE449/mw
P-22
Ser: 049
20 Mar 54

From: Commanding Officer
To: Commander Task Group 7.3

Subj: Radsafe Survey 8-11 March 1954

1. The Task Group 7.1 survey party and Mr. Marion Wilds, trust Territory representative, arrived Rongelap at 0745M, 8 March and boarded NICHOLAS shortly thereafter. Working parties, as indicated in Commander Joint Task Force SEVEN dispatch 060400Z, were made available to Dr. Scoville's party. Dr. Scoville informed the Commanding Officer that all reports of gamma intensitites and other scientific data would be reported only to Commander Joint Task Force SEVEN. He specifically requested that no other commands be made information addressee. Daily dispatches indicating results of RadSafe survey on each atoll, originated by Dr. Scoville, were addressed accordingly. On debarking at Eniwetok at 0830, 12 March Dr. Scoville's party transported all earth and water samples to Parry Island.

2. The following islands, in atolls, were visited. Mr. Wilds accompanied working parties ashore on all ex-inhabitated islands where native property was secured as directed by him.

a. Rongelap Atoll; 8 and 11 March 1954:

(1) Rongelap Island:

(a) Native houses were closed up and property left in the open, that could be ruined by weather, was moved inside.

(b) One dog and three cats were killed as possible menace to livestock.

(c) One thirty foot sailing schooner was beached above high water mark and filled with sea water. Masts were unshipped and placed in a shed along with sails.

(d) Two sacks of rice and five sacks of flour were opened and placed outside as feed for pigs and chickens.

(e) Buckets, pans and large clam shells were placed under eaves of houses to provide drinking water for livestock.

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(f) All livestock appeared to be in good condition. It is believed that sufficient water will be available although a shortage of food is expected to develop in the near future.

(g) Water and soil samples were taken as directed by Task Group 7.1 personnel and intensity levels were taken.

(2) The islands listed in sub-paragraph (3) through (15) are all uninhabitated except for parties of natives that go from Rongelap to make copra, collect sea birds and fish. There was no native property found. Intensity levels were taken by Task Group 7.1 personnel.

(3) Eniran Island.

(4) Arbar Island.

(5) Busch Island.

(6) Enialo Island.

(7) Eniaetok Island.

(8) Anidjet Island.

(9) Kabelle Island.

(10) Eriirippu Island.

(11) Lukuen Island.

(12) Gejen Island.

(13) Lomumilal Island.

(14) Aerik Island.

(15) Naen Island.

b. Utirik Atoll; 9 March 1954

(1) Itirik Island:

(a) Three canoes were beached above high water mark.

(b) Houses were closed up against weather and property left in the weather, that could be spoiled, was moved inside.

(c) Water catchments were provided for livestock by placing old pans, buckets and large clam shells under eaves of houses.

(d) Six dogs were killed to protect livestock.

(e) All livestock appeared to be in good condition.

(f) Water and soil samples were obtained and intensity levels taken.

(2) Aon Island:

(a) Uninhabitated - intensity levels taken.

c. Bikar Atoll; 9 March 1954

(1) Bikar Island:

(a) Uninhabitated - intensity levels taken.

d. Rongerik Atoll; 10 March 1954

(1) Eniwetak Island:

(a) Air Force personnel were landed along with a ship's working party. Spoiled meat and other consumables were dumped in the sea. Equipment was tested and secured against the weather as directed by Air Force personnel.

(b) Water and soil samples were obtained and intensity levels taken.

(2) The islands listed in sub-paragraph (3) through (6) are uninhabitated. Intensity levels, only, were taken.

(3) Rongerik Island.

(4) Mortlock Island.

(5) Latoback Island.

(6) Jock Island.

e. Alinginae Atoll; 10 March 1954

(1) Sifo Island:

(a) Native property, left by people who were visiting from Rongelap Island, was protected against the weather. All clothing, tools, etc. were placed inside a canvas shelter on top of dried palm fronds, and covered with additional canvas.

(b) A thirty foot sailing schooner was moved to a safe anchorage in the lee of Eniuetakku Island. The boat was anchored in a sandy spot in the event that it should sink. Beaching was impracticable due to the limited time available.

(2) Enibuk Island:

(a) Native property secured, intensity levels taken.

(3) Bokonikairu Island:

(a) Uninhabitated - intensity levels taken.

3. Navigation and general information:

a. Rongelap Atoll:

(1) Entrance can be made quite readily through South Pass and North east Pass. West Pass shows quite plainly, however, no passage was attempted because soundings are not adequate. Navigational fixes, using tangents were good. The Small Boat Passage in the Northwest part of the atoll is difficult to see and appears to be very dangerous when heavy swells are running.

(2) Landings can be readily made on all islands by motor whaleboat. On most of the islands the beach gradient was quite steep, permitting easy beaching of boats. A sharp lookout should be maintained at all times for coral heads and dark, yellow, or dark green, water should be avoided.

b. Bikar Atoll:

(1) Bikar Island Passage is very difficult to find and passage through the lagoon is difficult even for a small boat. A landing was made with very little difficulty in the lee of Bikar Island at low tide. It was found advisable to put the bow of the boat against the reef, which rises steeply at low tide, and let the party wade ashore. The water is only knee deep at this period of the tide. Backwash from the reef should be carefully watched.

(2) The island and surrounding water teems with fish, turtles and sea birds.

c. Rongerik Atoll:

(1) The ship did not attempt passage into the atoll because of the poor navigational aids available. It is believed that a shallow draft vessel should experience very little difficulty in making passage.

(2) Small Boating is rough, but not dangerous. Extreme care should be exercised when approaching Bock Island as many coral heads are present and the water is very shallow.

d. Ailinginae Atoll:

(1) Only small boat entry was made. A shallow draft vessel should have very little difficulty making entry. Navigational cuts were very poor.

(2) Small boating was rough but not dangerous.

e. Utirik Atoll:

(1) The four beacons shown on HO chart 6023 have been replaced by two black buoys. It is understood that the Trust Territory AKL makes regular entry into Utirik Atoll through Utirik Passage. The beacons on and around Utirik Island are missing.

(2) Small boating is not difficult, but a sharp watch should be maintained for coral heads.

4. Recommendations and Summary:

a. Survey of these atolls from a DDE type vessel is somewhat inefficient in that Rongelap is the only atoll, of the five visited, that can be entered and navigated safely, thus limiting the number of islands that can be covered in a given time. Boat handling operations outside the atolls were difficult due to heavy swells. With the forces available, it is believed that the use of a DDE is the most practicable solution for similar missions. For operations subsequent to "CASTLE", it is recommended that a smaller class ship of shallow draft be used. This would permit entry into most lagoons shortening boat runs, in some cases twenty miles.

b. Make boat entry into windward part of lagoon wherever possible. This permits boats to run down wind, speeding the operation and helping to keep instruments dry.

c. Maintain radio communication with boats. In this respect, this command used SCR 536 which were the only battery type radios available. Communications were fair. It is recommended that an SCR 608 or similar small battery radio with at least a thirty mile range be used if possible.

d. It was found advisable to provide the boats with overlays of the atolls showing magnetic compass courses between islands and passes.

e. Provide boats with food, water, binoculars and rifles. The last for protection against sharks in case a man falls over board.

f. Use stern anchor when beaching to prevent broaching. Do not let boat remain on beach, but haul out and await return of party.

g. Beach in the lee of island whenever possible.

h. It was found impossible to cover all of the islands in each atoll in the time allotted. Rough weather and long boat runs between islands in atolls slowed up operations. Task Group 7.1 scientific personnel designated the islands they desired to survey and landings were made on all so designated.

i. Working parties were kept firmly in hand. Each working party was required to remain in sight of a commissioned officer and Mr. Wilds. As far as could be determined, no native property was molested or pilfered.

j. It is estimated that the maximum accumulative dosage received by any one person in the parties was 2.5R. Film badges, worn by all personnel ashore or in the boats, have been forwarded to the U.S.S. BAIROKO for developing.

/s/J. C. ELIOT
J. C. ELIOT

Copy to:
COMCORTDESDIV 12

U. S. S. NICHOLAS (DDE-449)
c/o Fleet Post Office
San Francisco, California

DDE449/mw
P22
Ser: 054
28 March 1954

From: Commanding Officer
To: Commander Task Group 7.3

Subj: Rongelap Survey Trip 25 - 26 March 1954; report of

1. The USS NICHOLAS (DDE-449) departed BIKINI Atoll at 1900M, 25 March 1954 for RONGELAP Atoll in accordance with Commander Joint Task Force SEVEN 231131Z and Commander Task Group 7.3 232323Z of March 1954. The following personnel from Task Group 7.1 were on board:

Dr. Lauren R. Donaldson
Dr. Thomas L. Shipman
Dr. Edward E. Held
Dr. Ralph F. Palumbo
Dr. Paul R. Olson
Dr. Thomas N. White
Mr. William W. Robbins
Mr. Pasquale R. Schiavone
Major Charles M. Barnes, USAF

2. The ship arrived off the South Entrance, RONGELAP Atoll at 260100M and put a whale boat in the water at 260630M to meet the plane arriving from Kwajalein with Dr. Bond's party.

3. The ship then proceeded to Northeast Pass, RONGELAP Atoll, entered and anchored. Dr. Donaldson and his party departed the ship at 0830M.

4. The plane from Kwajalein arrived off RONGELAP at 0905M, was met by the whaleboat. Dr. Bond, Mr. Marion Wilds, three Public Health Service Officers, three Natives and miscellaneous equipment was transported to the beach. The plane was guided to an anchorage about two hundred (200) yards off shore from the village where it was anchored.

a. Personnel from the NICHOLAS assisted Dr. Bond to accomplish the following: Capture five young pigs and one sow; capture five chickens; obtain soil, fruit and vegetation samples. One boar was killed and an autopsy was performed on the spot. The animals and other samples were placed in cages and transported to the plane. Dr. Bonds party departed RONGELAP at 1300M, 26 March 1954. The whaleboat then departed RONGELAP Island and proceeded north to rejoin the ship, stopping at BUSCH and ENIAETCK Island to measure radioactive intensity. One member of RadSurvey Team accompanied this boat to conduct RadSurvey on Southeastern Islands. Dr. Donaldson's party worked in the Northeast part of RONGELAP Atoll, collecting fish, soil, birds, invertebrates, algae and vegetation samples. One member of RadSurvey Team accompanied this this party to conduct RadSurvey of Northern Islands. It was not possible to collect rats, as desired, due to the unexpected departure of the ship as directed by Commander Task Group 7.3 260217Z of March 1954.

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ENCLOSURE (4)

DDE449/mw
P22
28 Mar 1954

5. Dr. Bond expressed the opinion that his mission had been accomplished to his satisfaction. Dr. Donaldson stated that his mission has been accomplished satisfactorily. Mr. Marion Wilds, Trust Territory Representative requested that the boat at AILINGINAE be beached whenever practicable. All boats at RONGELAP have been beached by NICHOLAS.

6. Prior to the ships departure, three RT-176/PRC10 radios were obtained by Mr. P. Schiavone from Task Unit 7.1. These radios were very satisfactory and far superior to the BC-611-F used on the last trip. It is recommended that this type radio be used by ships on future trips if they are required to operate small boats a long distance from the ship. Reception was excellent at twenty (20) miles.

7. The ships departure from RONGELAP Atoll was delayed until 262130M because the motor whaleboat experienced a fuel pump failure on returning from KABELLE Island, where they were collecting rat traps.

8. The ship rejoined Task Group 7.3 off BIKINI Atoll at 270130M.

J. C. ELIOT

Copy to:
COMJOINTASKFORCE SEVEN
COMCORTDESDIV TWELVE

30 March 1954

MEMORANDUM FOR: CJTF SEVEN

SUBJECT: DDE Trip to Rongelap Atoll, 26 March 1954

1. Reference JTF SEVEN DTG 230220Z March 1954. Purpose of subject trip, conducted by USS NICHOLAS (DDE 449) was to:

a. Beach small boats belonging to Rongelap Marshallese.

b. Conduct radsafe re-survey of Rongelap.

c. Collect approximately 500 pounds contaminated top soil requested by AEC Division of Biology and Medicine.

d. Collect samples of Marine life and vegetation.

e. Collect domestic animals remaining at Rongelap village.

2. The undersigned acted as JTF SEVEN and TG 7.1 representative and was responsible for execution of 1b and 1c. Since the NICHOLAS will make an overall report, and detailed reports on 1d and 1e will be made by the project officers concerned, the details in this report are confined to 1b and 1c.

3. It is noted that the scope of activities 1b and 1d was more limited than had originally been planned. As will be clear from the report of the NICHOLAS, this was because 26 March became R-1 after the work started. Thanks mainly to the excellent planning and management of Capt. Joseph Eliot and Executive Officer Clifford Frink, much more was accomplished than might reasonably have been expected under these circumstances. 1c and 1e were accomplished essentially as planned, but 1a had to be omitted.

4. The radsafe re-survey was conducted by Mr. P.R. Schiavone of TG 7.1, TU-7, using two recently calibrated AN/PDR-39 instruments. Readings on Rongelap Island were taken during the morning and on the other islands during the afternoon of 26 March.

$t^{-1.8}$ decay from 11 March only

Island	mr/hr
Rongelap	40 at 0830 at standard position established by Scoville Survey
Boseh	50 South end
Eniaetok	90
Labardj	200
Kabelle	500

ENCLOSURE (5)

H - 4E

On Rongelap Island, the readings in the huts appeared to be 10%-15% less than outside. Inside the huts the readings at ground level were about 70% of those at head level. Readings over gravel areas and near the cisterns were about 30 mr/hr; inside the cisterns, about 10-15 mr/hr.

5. The top soil sample was obtained from LABARDJ Island a small island well covered with bushes and grass, but without palm trees. It had been planned to get the sample from KABELLE, but this could not be done without interfering with the fish and vegetation collection.

6. Special mention should be made of the work of Mr. P.R. Schiavone, who did an excellent job of getting supplies and equipment not available on the NICHOLAS, as well as conducting the rad-safe survey.

s/ T. White
t/ T. WHITE
H Division, LASL

H-47

MEMORANDUM FOR RECORD:

SUBJECT: Miscellaneous Radsafe Surveys of Rongerik (Surveys conducted v CTG 7.4)

RONGERIK

17 March, 1200 MIKE

Living Area Readings:

Mess hall interior	40 - 100 mr/hr	Waist level
Hospital interior	50-- 75 mr/hr	Waist level
Walk from hospital to mess	100 - 110 mr/hr	Waist level
Store room (behind mess)	50 - 55 mr/hr	Waist level
Exterior store room tent	100 - 150 mr/hr	Waist level
General Area exterior	100 - 150 mr/hr	Waist level

Weather Station Site Readings:

Exterior areas local	125 - 150 - 160 mr/hr	Waist level
Interior all tents	50 - 75 mr/hr	Waist level
Interior building	50 - 60 mr/hr	Waist level

Army Site Readings:

General area	140 - 190 mr/hr	Waist level
Interior tents	70 - 80 mr/hr	Waist level
Adjacent to trailer	160 - 180 mr/hr	Waist level

19 March, 1100 - 1220 MIKE

Landing on beach	42 mr/hr	Waist level
Living area	60 mr/hr	Waist level
Inside mess hall	22 mr/hr	Waist level
Inside dispensary	26 mr/hr	Waist level
Inside barracks	23 mr/hr	Waist level
ESE end of island (Rawinsonde)	47 mr/hr	Waist level
Along road to Rawinsonde area	40 - 42 - 40 mr/hr	Waist level
Inside weather building	23 mr/hr	Waist level
Work area outside building	60 mr/hr	Waist level
Army area (around trailer)	40 mr/hr	Waist level
Inside foilage area	40 mr/hr	Waist level
Inside tent	19 mr/hr	Waist level

19 March, 1400 MIKE

Inside weather building	21 mr/hr	Waist level
Living area Still	60 mr/hr	Waist level
Inside barracks	23 mr/hr	Waist level
Inside dispensary	25 mr/hr	Waist level

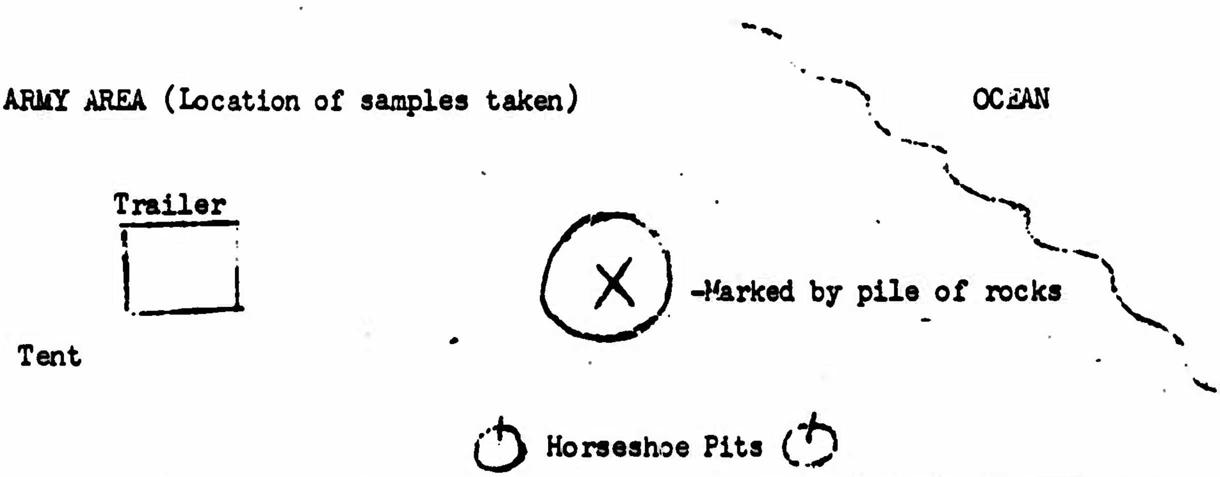
Inclosure 6

RONGERIK CON'T

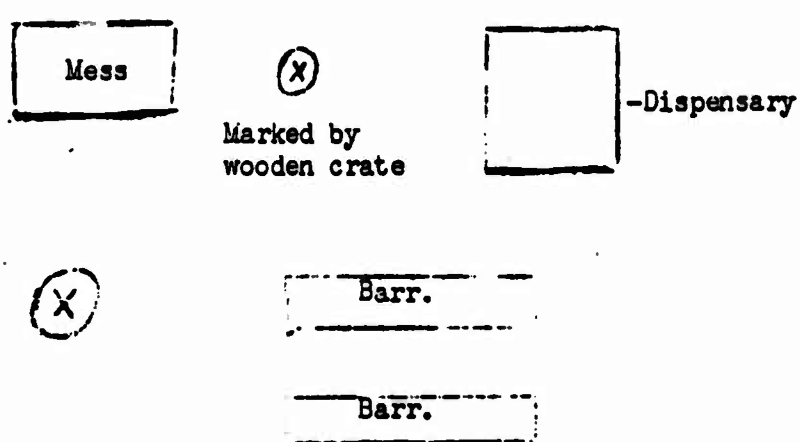
26 March, 1500 MIKE

Army Site -	Out	42 mr/hr	Waist Level
	In	20 mr/hr	Waist Level
Weather Site	Out	40 mr/hr	Waist Level
	In	18 mr/hr	Waist Level
Living Site	Out	35 mr/hr	Waist Level
	In	15 mr/hr	Waist Level

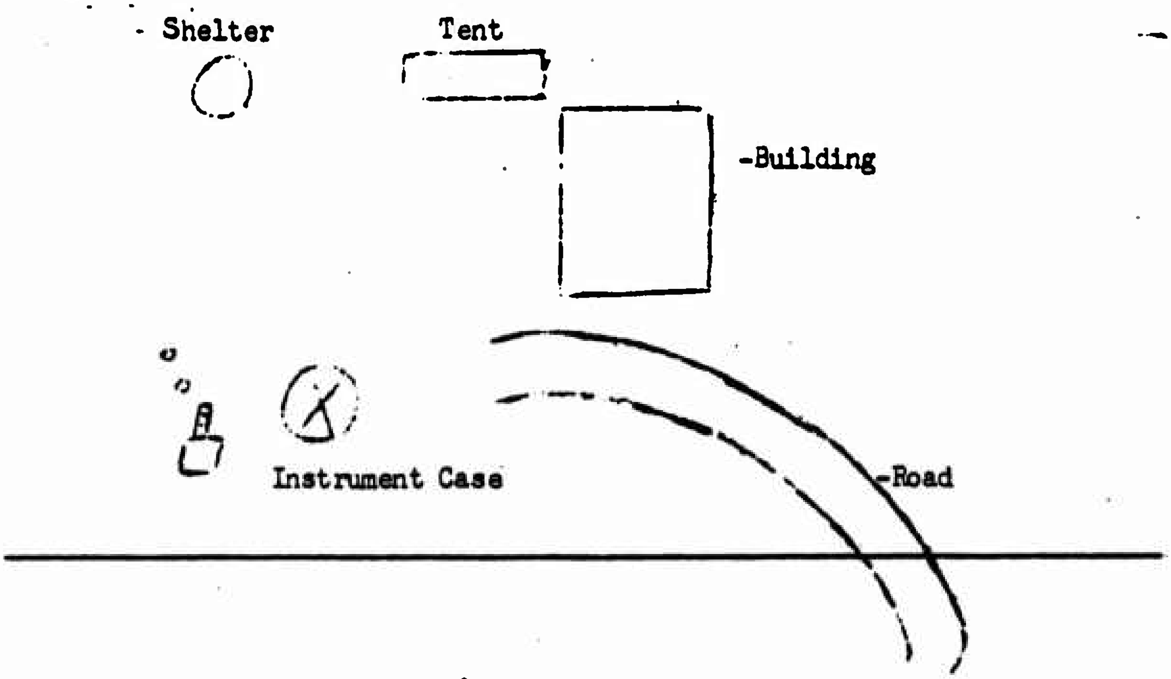
ARMY AREA (Location of samples taken)



LIVING AREA (Location of samples taken)



WEATHER SITE (Location of samples taken)



(s/t R. A. House
R. A. HOUSE
Lt Col., USAF
Ch. Tech Br, J-3
JTF SEVEN

MEMORANDUM FOR RECORD:

SUBJECT: Kwajalein-NYOO Flight ABLE Results

1. NYOO-Kwajalein Flight Able, consists of an aerial survey at approximately 200 feet altitude over the following atolls north of Kwajalein: Lae, Ujae, Wotho, Bikini, Ailinginae, Rongelap, Rongerik, Taongi, Bikar, Utirik, Taka, Ailuk, Jemo and Likiep. The aircraft are equipped with scintameters which are sensitive gamma radiation measuring instruments with a wide range, designed to measure ground contamination from altitudes of 200 to 500 feet.

2. Following Romeo snot at 261825Z March 1954, Flight Able was flown on the following dates with results indicated: (In mr/hr ground contamination)

Island (Atoll)	271900Z to 280317Z	302030Z to 310208Z
Lae (Lae)	0	0
Ujae (Ujae)	0	0.2
Wotho (Wotho)	0	1.7
Enibuk (Ailinginae)	6	26
Rongelap (Rongelap)	28	78
Rongerik (Rongerik)	36	58
Sybilla (Taongi)	1.0	0.4
Bikar (Bikar)	0.1	15
Utirik (Utirik)	--	7
Taka (Taka)	8	7
Kapen (Ailuk)	1.6	2.4
Jemo (Jemo)	0.8	2.4
Likiep (Likiep)	0.4	1.0

(s/t) R. A. HOUSE
Lt Col., USAF
ChTechOpns Br, J-3
JTF SEVEN

INCLOSURE 7

DRINKING WATER SAMPLES (Analysis Report)

SAMPLE NO.	COLLECTION DATE	TIME	LOCATION	DESCRIPTION	d/m/ml (ON SAMPLE DATE)
W1	6 March	0800	Likiep Island Likiep Atoll	Collected from largest cistern on heaviest populated island of atoll	77
W2	6 March	1200	Jemo Island	Same as W1	550
W3	6 March	1700	Ailuk Island Ailuk Atoll	Same as W1	1020
W4	7 March	1300	Majit Island	Same as W1	2500
W5-8	4 March	0900	Utirik Atoll	Composite of 4 water samples taken by USS RENSHAW	430
W11	5 March	1600	Ormed Island Wotje Atoll	Composite: ½ from catch-basin	100
W12	6 March	1130	Kaven Island Maloelap Atoll	1 from well	67
W13	6 March	1130	Kaven Island Maloelap Atoll	1 from catch-basin	31
W9	6 March	1630	Wotho Island Wotho Atoll	1 from well (catch-basin dry for 1 month plus)	7
W10	7 March	1200	Dalap Island Majuro Atoll	Tap Water	14
W11	3 March	0930	Rongelap Island	Composite of 6 bottles. Chart included to show location of bottles on Rongelap Island	94,000 120,000 47,000 No. 1 No. 6 24,000 11,000 63,000
W12	8 March		Rongelap Island	Central cistern of village	50,000*
W13	8 March		Rongelap Island	Cistern water from north part of island	73,000*
W14	8 March		Rongelap Island	Cistern water from northern most village	8,000*

INCLOSURE #8

DRINKING WATER SAMPLES (Analysis Report) Cont'd.

SAMPLE NO.	COLLECTION DATE	TIME	LOCATION	DESCRIPTION	d/m/ml (ON SAMPLE DATE)
W15	8 March		Rongelap Island	South cistern in village	60,000*
W16	9 March		Utirik Island	Cistern	7,200*
W17	9 March		Utirik Island	Cistern	33,000*
W18	10 March		Eniwetak Island Rongerik Atoll	Distillation water	66*

* computed as of 3 March

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SOIL SAMPLES (ANALYSIS REPORT)

SAMPLE NO.	COLLECTION DATE	TIME	LOCATION	DESCRIPTION	d/m/gm (ON SAMPLE DATE)
S1	6 March	0800	Likiep Island Likiep Atoll	Upper layer bare soil in random spots unsheltered by trees or shrubs etc.	23,000
S2	6 March	1200	Jemo Island	Same as above	13,000
S3	6 March	1700	Ailuk Island Ailuk Atoll	Same as above	23,000
S4	7 March	1300	Mejit Island	Same as above	30,000
S5	5 March	1600	Ormed Island Wotje Atoll	Composite of 5 samples (1 beach, 3 mid-village, 1 back village)	15,000
S6	5 March	1730	Erikub Island Erikub Atoll	Composite of 2 samples (1 mid-village, 1 half-way to beach)	4,300
S7	6 March	1130	Kaven Island Maloelap Atoll	Composite of 4 samples (2 from village, 2 from paths to beach)	5,500
S8	6 March	1630	Wotho Island Wotho Atoll	Composite of 3 samples (1 by well, 2 mid-village)	2,400
S9	7 March	1200	Dalap Island Majuro Atoll	Composite of 4 samples (near Admin Bldg)	950
S10	7 March	1200	Utirik Island	Composite of 3 samples	270,000
	(Collection date of S10 is uncertain, probably 3 March 1954 by PBM Survey Party. Analysis value given is corrected to 7 March.)				
S11	8 March		Rongelap Island	Soil from north part of island	1,300,000**
S12	8 March		Rongelap Island	Center portion of island	7,400,000**
S13	8 March		Rongelap Island	1 mile north of Rongelap village	460,000**

INCLOSURE #9

SOIL SAMPLES (ANALYSIS REPORT) CONT'D

SAMPLE NO.	COLLECTION DATE	TIME	LOCATION	DESCRIPTION	d/m/gm (ON SAMPLE DATE)
S14	8 March		Rongelap Island	Near south cistern of village	630,000**
S15	8 March		Eriirippu Island Rongelap Atoll		35,000,000**
S16	8 March		Eniwetak Island Rongerik Atoll		3,200,000**
S17	8 March		Kabelle Island Rongelap Atoll		20,000,000**
S18	9 March		Utirik Island		5,600,000**
S19	9 March		Bikar Island		280,000**
S20	10 March		Eniwetak Island Rongerik Atoll		1,200,000**
S21	10 March		Sifo Island Ailinginae Atoll	Temporary village	84,000**
*S22	9 March		Bikar Island	Foliage, windward side	460,000**

* d/m/gm of plant ash (Equiv. to 1.4 x 10^4 d/m/gm plant as received)

** Computed as of 3 March

Soil values may be roughly translated to curies per square mile by dividing by 13, or to d/m/ft^2 by multiplying by 6000.

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

J-3/370.05 1 May 1954

SUBJECT: Miscellaneous Reports Related to the Atomic Detonation on 1 March 1954

TO: See Distribution

1. References:

a. JTF SEVEN letter, J-3/729.3, subject: Radiological Surveys of Several Marshall Island Atolls, dated 18 March 1954 (SECRET - RESTRICTED DATA)

b. JTF SEVEN letter, J-3/370.05, subject: Reports on Evacuation of Natives and Surveys of Several Marshall Island Atolls, dated 9 April 1954 (CONFIDENTIAL).

2. Attached herewith for your information and retention are copies of additional meterial pertaining to the above references. The limited number of contact prints available permits distribution of sets to the following only: C/S USA (ExAgt), DMA (AEC), DBM (AEC), HICOMTERPACIS, CINCPAC, CINCPACFLT, ChAFSWP, COMNAVSTAKWAJ. Additional prints may be obtained as indicated in reference 1b.

P W Clarkson
P. W. CLARKSON
Major General, U.S. Army
Commander

4 Incl
1. Preliminary Report (Eisenbud) to DBM (AEC) (Bugher) on Contamination of the Fukuryu Maru and Associated Problems in Japan (undated).
2. Chart: The Route or Position of Fukuryu Maru V.
3. M/R: Additional Ground and Air Radsafe Survey Data During Period BRAVO to BRAVO plus 5 days.
4. Black and White Contact Prints (247 separate prints) Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives (1 set to each command or agency indicated above)

H-56

J-3/370.05 1 May 1954

SUBJECT: Miscellaneous Reports Related to the Atomic Detonation on 1 March 1954

DISTRIBUTION:

CTG 7.1 (30 cys)
CTG 7.2 (1 cy)
CTG 7.3 (1 cy)
CTG 7.4 (1 cy)
CTG 7.5 (1 cy)
CINCPAC (1 cy)
CINCPACFLT (1 cy)
HICOMTERPACIS (1 cy)
COMNAVSTAKWAJ (1 cy)
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DBM/AEC (1 cy)
Ch AFSWP (1 cy)
CG FldComd (DWET) (1 cy)
C/S USA, ExAgt (1 cy)
LASL H Div (1 cy)
HASL, NYOO (c/o Mgr Opns) (2 cys)
USS RENSHAW (DDE-499) (1 cy)
USS PHILIP (DDE-498) (1 cy)
USS NICHOLAS (DDE-449) (1 cy)

H. 57

JOHN C. BUGHER, MD

MERRIL EISENBUD

CONTAMINATION OF THE FUKURYU MARU AND ASSOCIATED PROBLEMS IN JAPAN: PRELIMINARY REPORT

I have recorded some of the observations made during my visit to Japan to assist in the various problems arising out of the mishap to the Fukuryu Maru. I am sending this along to you at this time because you will no doubt want a preliminary report prior to my return to the states in about 2 weeks.

This memorandum is intended to augment the report that Dr. Morton will submit to you. I have attempted to limit myself to factors other than those associated with the clinical phases of the problem, with which Dr. Morton's group are concerned.

THE INCIDENT

The mishap which befell the Fukuryu Maru became known to the Embassy and the world on March 16 through reports in the Japanese press. This was two days after the 100-ton fishing vessel had returned to its home port of Yaizu. The facts of the incident, as determined by the Japanese Foreign Office and communicated (1) to the Ambassador, are as follows:

(1) The course of the vessel from its departure on January 27 to its return to Yaizu on March 14 is plotted in Figure No. 1. At 0412 hours on March 1 a streak of light reported by the crew is believed to identify the time of detonation. The vessel's position was approximately 11° 53½' north and 166° 34½' east. This position is only a few miles from the easternmost limit of the Marshall Islands danger area in effect at that time.

(2) Two blasts in succession were heard about 7 or 8 minutes after the light had been seen. The crew is reported to have become apprehensive and began at that time to haul in their fishing lines, an operation which continued until 1030 hours, at which time the vessel headed north "to get out of the area".

(3) At about 0700 on March 1, ashes began to fall, turning the deck white. The position of the vessel at this time is given at 11° 56 3/4' north and 166° 42½' east. The ashes kept falling until noon at which time the position of the vessel was estimated at 12° 14' north and 166° 53' east.

(1) Aide Memoire of March 27

H-58

Incl 1

(4) At 0440 hours on March 2, the vessel shifted its course toward its home port of Yaizu, where it arrived at 0600 on March 14.

(5) In the following two or three days, all the crew reported slight headaches and some of them were nauseous. In 7 or 8 days, evidence of burns on exposed parts of the body began to appear.

In rēsponse to certain questions which the Ambassador asked the Foreign Service, the following information was received. It sheds some light on the sequençe of events during the 2 days following the return of the Fukuryu Maru to Yaizu, but before the mishap had come to the attention of the Embassy.

(1) The crew first contacted the ship's owner, and the director of the Fisherman's union. On the day of their return crew members who were seriously affected consulted a physician of the Kyoritsu Hospital.

(2) Two of the fishermen, Yamamoto and Masuda, who were in more serious condition left the Kyoritsu on March 15 for Tokyo where they visited Doctor Shimizu at the Tokyo University Hospital.

(3) Professor Shiokawa made radiation measurements of the ship on March 16 and on the basis of his findings all of the crew members consulted a physician who recommended that the men be hospitalized.

THE ROLE OF THE JAPANESE SCIENTISTS

During the latter half of March the Japanese press was fed continually with sensational statements from Japanese Scientists. The motivations of the Japanese were never quite understood by us but the following factors may be enumerated as pertinent to our lack of progress in dealing with them:

(1) In a long private conversation that I had with Dr. Tsuzuki at his home on the evening of March 24, he was frank in stating his apprehension that the American scientists would deny him and his associates professional recognition due them for their accomplishments in the diagnosis and treatment of the fishermen. He referred frequently to his experience in 1945 when he lead the teams of Japanese investigators into Hiroshima and Nagasaki only to have his work interrupted by the Occupation investigators who undertook their own studies. Dr. Tsuzuki seemed to accept my assurances that in the present situation it was the intent of the American scientists to assist the Japanese and that all of our findings would be available to them and could be used as they saw fit in their own publications.

Dr. Tsuzuki was outwardly friendly to both Dr. Morton and myself until the time of his departure for Geneva on March 31. Despite this, the lack of cooperation continued to be manifest on the part of the Japanese investigators. I do not know whether this was because we misjudged Dr. Tsuzuki's friendliness, or because he lacked influence on his japanese colleagues.

(2) There was much evidence of rivalry among various Japanese medical groups. In particular, the staff at Tokyo University headed by Dr. Tsuzuki, were initially at odds with the group at the National Institute of Health, headed by Dr. Kobayashi. Moreover, the local physicians at Yaizu, where all but two of the patients were hospitalized until March 29, were anxious for various reasons that the patients remain there. Their lack of cooperation with the American scientists may have been motivated by their knowledge that the Americans advised that the patients be transferred to Tokyo:

(3) Many of the accepted procedures of modern American medical practice seemed strange to the Japanese, and their concepts are strange to Us. For example, access to patients by any physicians was denied for several days because the Japanese physicians found their patients to be in a highly excited state and preferred not to disturb them. Japanese physicians indicated on several occassions that the taking of duplicate blood smears by Japanese and American investigators was an unnessary duplication, and an ordeal that the patients should not be expected to undergo.

In my initial conference with the Japanese scientists I was forced to the conclusion that they were not well equipped to deal properly with the radiological aspects of the problem. For example:

(1) Some of the top scientists took the position that because a new kind of bomb was involved, the problem itself was a new one, and that unless they know all about the bomb, they could evaluate neither the injury to the fishermen nor the aspect of long-range contamination of Japan and its fishing crews throughout the Pacific.

(2) The were quick to identify qualitatively some of the radioactive isotopes in the ash and immediately concluded that deposition of these radio-isotopes in the tissues of the men was the prime factor in their medical status. This decision was reached without benefit of radio-chemical urine analyses of the patients. This procedure which was beyond the capability of their laboratories is of course a prerequisite to understanding the amount and kind of fission product absorption that actually occured.

(3) The University of Tokyo group administered parentally a massive dose of ash to one mouse, and following sacrifice 12 hours later, determined by radiography that radioactivity was present in the mouse skeleton. The activity of the dose was not measured. The fact that the radioactivity was detected by the scientists in the skeleton of the mouse was widely publicized as evidence for their conclusion that the patients were carrying dangerous internal deposits of radioactive isotopes.

As individuals, the scientists seemed anxious to cooperate. In my initial conversations with them they freely asked for help and seemed gratified at some of the things that we could do for them. My participation on the American team was limited to the radiological aspects of the case and only incidentally to the patients themselves. Unfortunately the nature of Dr. Morton's participation required that he be given direct access to the patients and this the Japanese consistently refused to grant. As the days went by and the Japanese became more resolute in their decision to deny access to the patients, other areas of the problem became infected by the uncooperative atmosphere. This will become apparent in subsequent portions of the report.

OFFERS OF ASSISTANCE TO THE JAPANESE

When I arrived in Tokyo on March 22 Dr. Morton had already offered to the Japanese the full facilities of the Atomic Bomb Casuality Commission. General Hull had likewise offered the facilities of the Far East Command. These offers were accompanied by a spirit of sympathy and the desire to assist the Japanese investigators in their efforts to evaluate the incident and to restore the health of the fishermen. At a meeting with top

Japanese scientists and government officials on March 24, I made a further offer, in behalf of the Atomic Energy Commission, to provide whatever facilities were available for evaluation of the radiological factors involved in the incident. I repeated the assurances repeated earlier by Dr. Morton that we wished sincerely to be of assistance, that our participation was not motivated (as some Japanese suggested) by the opportunities for scientific studies, and that whatever data we obtained would be turned over to the Japanese investigators to be used by them in any way they saw fit.

At this point it would be desirable to list the radiological studies which had been already made by the Japanese. These studies are of interest because they indicate the extent of Japanese capabilities in this field, and define the extent to which our facilities would be helpful to the Japanese.

(1) Using a Cutie Pie, they measured the radioactivity of the Fukuryu Maru. These data appear completely satisfactory and prove to be in good agreement with measurements made with American calibrated equipment.

(2) They measured radioactivity of the fish and fishermen, using portable survey equipment. However, their equipment was not calibrated and their data were given in counts per minute as determined by the original factory calibration.

(3) They determined that the ash recovered from the vessel was radioactive using an end window GM tube and scaler. Their counting system was not calibrated and they reported counts per minute with no knowledge of the factor required to convert their data to standard units.

(4) They completed a qualitative radiochemical analysis of the ash and reported the following: Sr 89, Y91, Zr95, Nb95m, Nb95, Ru103, Ru106, Rh106, Sb127, Te132, I131, I132, Ba140, La140, Ce141, Ce144. (More recently they have completed a semi-quantitave analysis for a few isotopes).

(5) They had scanned the bodies of the fishermen with a GM probe.

(6) They had administered a dose of ash to 1 mouse, as described earlier.

(7) Using an imersion type GM tube, they had demonstrated radioactivity in the urine of 3 fishermen. As before, their equipment was not calibrated and the absolute activity could not be determined.

With this as the status of their investigation at the time of my arrival, and following several hours during which I acquainted the Japanese with our experience in this field, I offered the following services to them:

(1) Complete radiochemical analysis of 24 hour urine collections from all patients. In view of the importance of this analysis in evaluating the status of the patients, I urged that these samples be furnished immediately and assured them that in one week it would be possible to give them a report for the constituents of principal biological importance. I explained the need for serial samples and suggested that collections be made at weekly intervals. They seemed anxious to accept this service.

ACTION: This offer was made on March 24. On March 26 we obtained urine from two patients. On April 1 we obtained urine from 5 more. We have not obtained urine from the remaining 16 patients despite our repeated attempts to do so.

(2) I offered to scan the fishermen for radiation, using two Scintimeters that I had available.

ACTION: I have been unable to do this because they have not permitted the American team to have access to the patients.

(3) In response to the Japanese request I offered to provide a report on the biologically significant radio-isotopes present in the ash.

ACTION: Dr. Nakaizumi gave me a small amount of deck sweepings from the Fukuryu Maru. This I have sent to the Health and Safety Laboratory for future study. The composition of the ash was actually known to the Commission from analysis performed by the Air Force on the material obtained from the Fukuryu Maru Prior to my visit. Authorization for transmission of this information to the Japanese was communicated to me in telegram No. 2199 from the Secretary of State to the Ambassador. I transmitted this information to Dr. Kobayoshi on April 7.

(4) I offered to arrange for animal studies which would provide useful information on absorption and metabolism of the various radiochemical components of the ash.

ACTION: The Japanese reported the extent of the total amount of ash recovered as 50 millocuries. They now deny that this much is available and have no inventory of the material. Except for the small amount of ash turned over to me by Dr. Nakaizumi and a similar amount which I recovered on a subsequent visit to the Fukuryu Maru, no ash has been made available to us.

(5) In response to Japanese requests, I agreed to recommend monitoring procedures for the tuna inspectors.

ACTION: Monitoring procedures was devised but I deferred the question of maximum permissable contamination until more information became available on the extent and type of contamination. I agreed to stand by until the first contaminated tuna were found by inspection, at which time I would go to the scene of inspection and recommend specifically on the basis of my own observations whether the catch should be accepted or rejected. As noted elsewhere in some detail, the Japanese never permitted me to examine tuna which was alledgely contaminated.

<u>SPECIAL PROBLEMS ARISING OUT OF THE INCIDENT</u>

The mishap to the Fukuryu Maru created a number of separate, but interrelated problems. Of these, the most urgent was the clinical status of the 23 fishermen, a subject with which Dr. Morton is exclusively concerned and about which he will report separately. Other problems which required attention were:

(1) Contaminated Tuna.

(2) Apprehension of long-range contamination of Japan and its fishing grounds.

(3) Radiological factors affecting the fishermen:

(a) Estimating the whole body dose.

(b) Estimated dose from internal emitters.

Contaminated Tuna

Some of the Japanese Government officials are already referring to the latter half of March as the "great tuna panic". The origin of this panic both in the United States and Japan is worthy of careful study. the extent of the tuna consumption in the United States and Japan declined during the second half of March is now known to me at this time. For a day prior to my departure from New York on March 19, and for 2 weeks following my arrival in Tokyo on March 22 the subject of radioactive tuna was a subject of popular conversation. When one considers the reaction of the informed American public to the possibilites of contamination of tuna it is not surprising that the Japanese were stampeded into apprehension over the immediate prospects of their eating radioactive tuna and the long-range prospects of their fishing grounds being ruined.

(A) Tuna Fishing Industry of Japan L/

The Japanese fishing fleet at the present time consists of about 1,000 vessels operating out of ten major ports. The annual value of the tuna catch approximates $26 million. The principal export species is albacor. Sixty percent of the landed albacor catch went to Japanese canners and forty percent was shipped abroad in freezers. Sixty percent of the albacor are caught in the summer season which extends from May through July. During this season, the fishing grounds are located relatively close to the Asiatic coast.

During the winter months, January through March, the Japanese vessels range far out to sea. The winter season accounts for forty percent of the annual catch.

(B) Contaminated Tuna in Japan

The Fukuryu Maru landed at Yaizu with a catch of 28,000 pounds of tuna. We must accept the fact that these tuna were excessively contaminated and that the decision of the Japanese to dispose of those

L. An excellent report of technical information about the Japanese Tuna fisheries in Japan is report No. 104 issued by the Natural Resources Section of SCAP in March, 1948.

fish was a wise one. There is reason to believe that contamination was confined to the surface of the fish and occured when the radioactive ashes fell and entered the ships hold.

With the decision of the United States Food and Drug Administration to monitor incoming shipments of tuna, the shipping companies operating out of Japan initiated a requirement that the Japanese certify export shipments as being free of radioactivity.

When I arrived in Japan on March 22, the Japanese had already monitored their first outgoing shipment of frozen tuna. The Ministry of Welfare undertook to have its sanitation inspectors trained in the use of geiger counters and began the routine inspection of both incoming and outgoing tuna at five ports. All vessels were instructed to return to one of these ports. Five geiger counters were obtained from the Far East Command and loaned to the Japanese. In addition, they mustered approximately the same number from various sources in Japan.

On March 24, at a conference with the Japanese Government officials, they asked for my recommendation for maximum permissible contamination. They also asked that I recommend the kind of examination that should be made of the fish.

Because of my unfamiliarity with the mechanical details of handling tuna shipments, I suggested that I be permitted to study tuna loading operations scheduled for the following day. Thereupon it was arranged that I should accompany Japanese officials to Yokohama where the Batan was being loaded with frozen albacor.

Tuna shipments involve many fish and it is not an easy matter to monitor properly with inexperienced personnel and only a few survey instruments. Based on my inspection of the Batan, I suggested that every tenth fish be monitored for about 1 minute by passing an open window GM probe over the surface of the fish, paying particular attention to the gills. I also instructed them to insert the probe into the mouth of the tuna and into the abdominal incision through the fish.

There remained the question of criteria for rejection of fish found to be contaminated. Again it is not a simple matter to evaluate the risk to a consumer of tuna from measurements made in this way. I informed the Japanese that I was unable to propose a realistic figure without some study. On the other hand it was my belief that significantly contaminated fish were not likely to be found. Low level fall out to the skins of the fish was, of course, a possibility. This seemed to be of little significance in view of existing cannery practices which strips the skins from the fish when processing begins. I told the Japanese I would be standing by in Tokyo, that they should continue to monitor the fish by the method I proposed, and that when and if contaminated fish were found I should be advised and given the opportunity immediately to make a first hand inspection of the fish. My recommendations would depend on what I found.

No contaminated tuna have been brought to my attention. Newspapers have occasionally reported incoming shipment of contaminated fish but the Japanese had not requested that I make an examination of them.

The following sequence of events illustrates some of the difficulties we have had:

(1) On March 31 we read in one of the Tokyo English language newspapers of two fishing vessels that were contaminated. The Embassy called the Ministry of Foreign Affairs who reported the following information by telephone:

(a) The Koei Maru, then at the port of Misaki, was at 9 degrees, 22 minutes north, 178 degrees, 19 minutes east on March 1. The surface of the ship was re ading 2443 counts per minute, the catch 155 counts per minute and the men 500 counts per minute. The fish had been impounded awaiting a decision as to their safety.

(b) The Myojiim Maru was at Shiogone. On March 1 it was at 29 degrees, 8 minutes north, 177 degrees, 19 minutes east. The surface of the ship was reading 50 to 400 counts per minute, the fish 56 to 84 counts per minute, and the crew 40 to 90 counts per minute.

(2) The Embassy informed the Ministry of Welfare of my interest in seeing the ships and fish and told them a special plane would be available to fly me to the two ports. The Foreign office was requested to arrange for access to the vessels and was invited to send whoever they wished to designate with me on this trip. A flight was scheduled for early on the morning of April 2.

(3) Around noon on April 1 the Foreign Ministry called the Embassy and advised that the Myojiim Maru had left Shiogone that morning, that its destination was not known, and that the fish had been disposed of in an unknown manner. The Embassy informed the Foreign Ministry that, this being the case, we would limit our trip to Misaki.

(4) At 4 PM on the afternoon of April 1 the Foreign Ministry again called to inform the Embassy that the Koei Maru had left the port of Misaki one hour before to dump its contaminated catch at sea. The Embassy asked the Foreign Ministry to call the vessel back inasmuch as it was only one hour off port but the Japanese stated this could not be accomplished.

To summarise the tuna situation, it is my belief that no significantly contaminated tuna have arrived in Japan except for the catch from the Fukuryu Maru. Rigerous inspections procedures will undoubtedly disclose certain amounts of low level radioactivity on the surface of the tuna but the significance of this is minimized by the practice of skinning tuna prior to canning. In the meantime the tuna market has stabilized and tuna representatives of American tuna interests have informed me that their companies are no longer concerned over the problem.

Apprehension of Long Range Contamination of Japan and its Fishing Grounds

Japenese apprehensions over the posibility of long range radiologieal contamination were very similar to those we encountered in the United States as a result of NPG operations.

A difference in Japan is due to the fact that none, if any, of the counting equipment is calibrated, GM tubes are used without shields, and under conditions where the background count is apt to be highly variable. This, coupled with the fact that they do not know the background activities of such things as soil and biological materials, makes it very difficult to evaluate the reports. Many of the reports of "ash" falling in various parts of Japan are undoubtedly dust or soot falls that occur normally in any industrial area from time to time. Reputable scientists have examined samples of potassium-rich soil and have reported their date is gross counts without any reference to normal soil background. For this reason I find it very difficult to take serious the frequent public report of 50 to 100 counts per minute for the unspecified size of samples reported from time to time.

At my conference with the Japan scientists and government officials on March 24, I explained the procedures we use in the States for measuring fallout. I urged them to use similar procedures for the sake of uniformity and offered to loan them the equipment we used. They seemed eager to accept and I requested 4 sets of equipment which has since arrived from the States. However, since the arrival of this equipment, I have delayed giving it to the Japanese because in their present state of mind little good could come of it. I do believe, however, that when the present confusion subsides, it will be useful for the Japanese to maintain a fallout monitoring network and I think we should cooperate with them to the fullest extent.

In a conference with Dr. Kobayoshi on March 26, I informed him of my conversation with Dr. Bugher and his offer in behalf of the Atomic Energy Commission to provide financial support for marine biological studies directed at the long range contamination of the Pacific. Dr. Kobayoshi, through his interpretor, expressed his appreciation for this offer but did not pursue the matter further and has not approached me since.

With regard to fallout on the Japanese islands themselves, it is to be remembered that the position of those islands in relation to possible sites of weapons testing is such that the Russian testing program is apt to produce more fallout than events in the Marshalls or Nevada.

Estimating the Whole Body Dose

I doubt that it will be possible to make a satisfactory estimate of either the Beta or Gamma dose the fishermen received. We know that the ash fell in such quantities that the deck of the ship became white, and there was sufficient material to develop visible footprints. Unfortunately, this is the limit of our information on how much ash fell and how long it remained on the ship. The fishermen washed the decks in order to remove the ash and according to their reports their washing was effective. When the vessel arrived in Yaizu much of what remained was removed.

Measurements made by various investigators during the period between March 20-26 are in agreement. It is curious that the Beta-Gamma ratio is about 1. This would indicate that the bulk of the ash had by this time penetrated to the porous wood structure of the deck, thus absorbing the Betas. The Gamma radiation over most of the ship was approximately 40 m.r. per hour when the ship arrived in port. If we extrapolate this back to H ≠ 3 hours, the time the ash began to fall, the integrated Gamma dose is about 100 R. Of course, the ash was falling from H plus 3 hours to about H plus 9 hours. If we take the mid-point of this period as the start of exposure we find the exposure is about 70 R. This, however, estimates the whole body Gamma radiation from residual debris still on the ship when the first measurements were made. The actual dose could have been 2, 10, or even 100 times higher depending on how much ash was washed off the ship and at what time.

We have made a number of discreet inquiries in the hopes that photographic film might have been available aboard the ship and might possibly be used as a dosimeter. All efforts to date have been negative.

Deposition of Internal Emitters

There was an urgent requirement to evaluate the extent to which fission products had been absorbed into the tissues of the fishermen. As mentioned earlier, Dr. Nakaidzumi had concluded from his mouse experiment that the prognosis for the fishermen was adversely affected by the probability of excessive deposition of long-lived bone-seeking isotopes. The Japanese scientists were desperately looking for an agent to mobilize these isotopes and Dr. Lewis believes that they had administered EDTA to the patients, despite the fact that urine analysis was beyond their capability and they were therefore unable to determine either the need for EDTA or the effect produced by it. Apart from the fact that they were unable to undertake urine analysis at that time, it is also evident that they did not understand the dynamics of fission product metabolism and were not used to thinking in terms of urinary excretion levels as an index of absorption and deposition.

They were anxious to provide me with samples of urine for State-side analysis. Two samples were delivered on March 26 and five more on March 30. As yet we have not received samples from the remaining 16 patients. The samples received were properly forwarded to the Health and Safety Laboratory and I have had the results of gross analysis of the first two samples. I communicated these results to Dr. Kobayashi in the attached letter which is self-explanatory.

THE FOREIGN SERVICE
OF THE
UNITED STATES OF AMERICA

6 April 1954

Dr. Rokuzo Kobayashi
National Institute of Health
Welfare Ministry
TOKYO

Dear Dr. Kobayashi:

On March 26 we received two samples of urine from patients at the Tokyo Univeristy Hospital. I am happy to be able to report at this time that the radioactivity of these samples is so low that the deposits of fission products in the tissues of the two patients can be accepted as well within the limits of safety. The results follow:

- 720 disintegrations per minute per liter
- 510 " " " " "

Data on the individual radio-isotopes will be telegraphed to me in another few days. It will then be possible for me to be more quantitative in estimating the dose from absorbed fission products. However, it is most certain that the storage of long-lived radio-isotopes is insignificant in these men.

As you know, the rate of excretion of fission products at any given time after absorption bears a relationship to the quantities deposited in the various tissues. The principal radiochemical constituents at this time are due to Sr 89, La140 and the Rare Earths. These are isotopes which have relatively short half-lives and are eliminated from the body with comparative rapidity either by radioactive decay or excretion. In the case of these patients, Sr90 is most certainly an insignificant fraction of the total absorbed radioactivity. The permissible urinary excretion, considering the isotopes involved, would be greater, by a large factor, than the values reported above.

I note that the newspapers continue to carry occasional statements of the Japanese investigators to the effect that the prognosis for the fishermen is adversely affected by the fact that long-life bone-seeking isotopes are deposited in their tissues. It is regrettable that the public continues to be misinformed in this respect. Certainly the results reported above argue convincingly that only minimal, medically insignificant amounts of fission products have been absorbed into the tissues of the two patients for whom results are available.

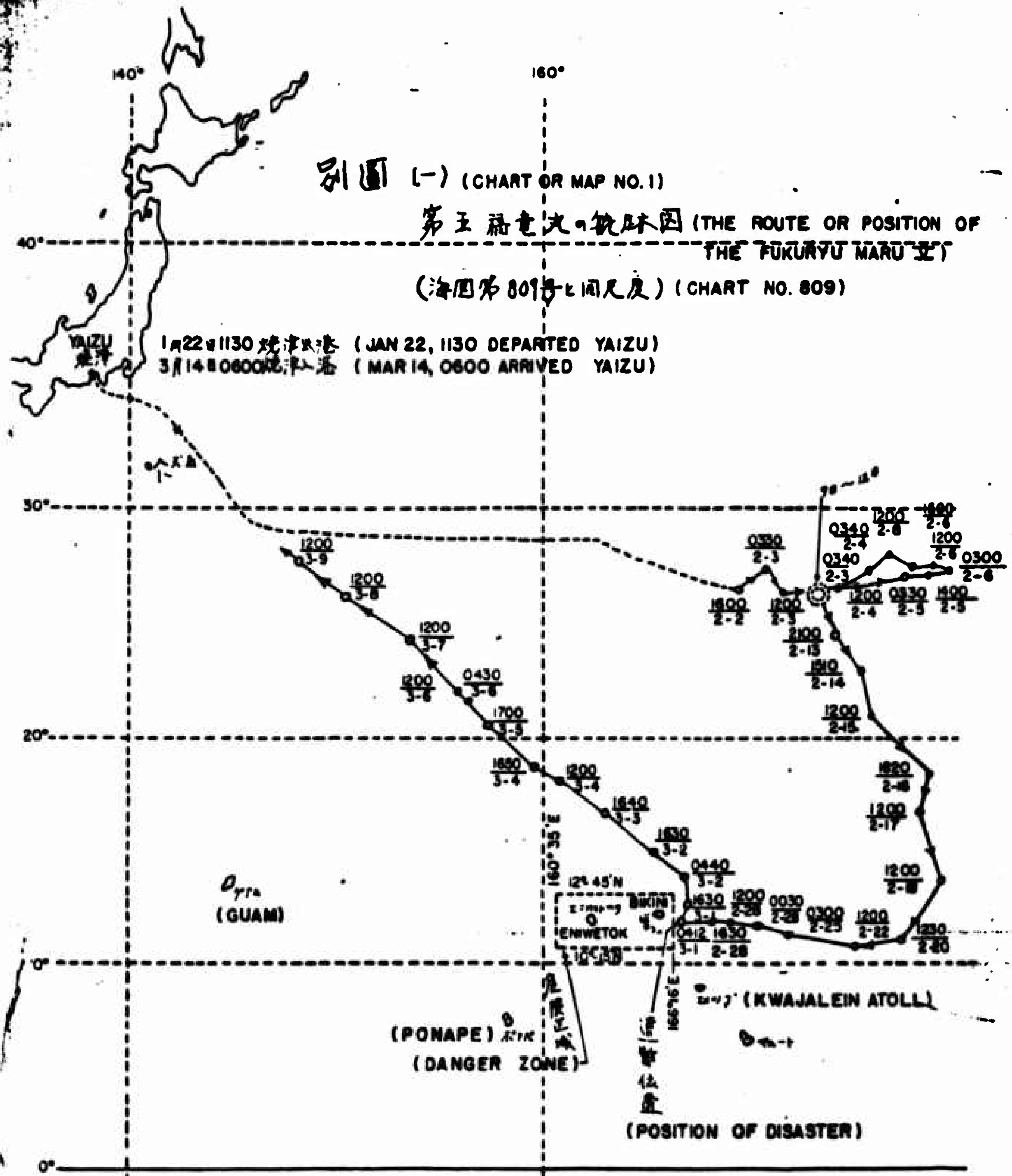
I regret that I am unable to give you the results of analysis of urine from the 21 other patients. Knowing that those data would be highly important to your committee in its evaluations of the medical status of these patients, we have offered to undertake radiochemical urine analysis of all 23 patients. The urine from only two patients has been delivered to us in time to permit shipment to the States and analysis by this date. More recently, samples from five additional patients from the Tokyo University Hospital were delivered to us, but we have not as yet received samples from the 16 patients now hospitalized at the Daiichi Hospital.

Respectfully yours,

Merril Eisenbud
Director, Health and Safety Laboratory
United States Atomic Energy Commission

ME/ams/hcc

CC: Dr. Nakaidzumi
Dr. Kakehi



FROM AIDE MEMOIRE OF MARCH 27, (TIMES ARE JAPANESE)

(SHIP REPORTED TIME OF FLASH 0412, 1 MARCH 1954 (LOCAL OR SHIP'S TIME)

POSITION OF FUKURYU MARU

TIME OF BURST ---------------- 11° 53$\frac{1}{4}$ N, 166° 34$\frac{1}{4}$ E

TIME FALLOUT STARTED ------------- 11° 56$\frac{3}{4}$ N, 166° 42$\frac{1}{2}$ E

TIME FALLOUT STOPPED ------------- 12° 14' N, 166° 53' E

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

19 April 1954

MEMORANDUM FOR RECORD

SUBJECT: Additional Ground and Air Radsafe Survey Data During Period BRAVO to BRAVO plus 5 Days

1. Following are readings from radsafe surveys during the period B to B plus 5 days:

a. Special ground surveys from PBM survey flight and DDE evacuation parties: (All times Zebra, March 1954.)

		Waist height on AN/PDR T1B in mr/hr
Eniwetak Island (Rongerik Atoll)	012315	2000
Rongelap Island	020645	1400
Ailinginae Island	030445	445
Utirik Atoll	030145	160
Eniaetok Island (Rongelap Atoll)	020645	3000

b. NYOO ABLE, BAKER and CHARLIE flights originating from Kwajalein, flights GEORGE and ITEM originating from Oahu, flight EASY originating from Guam, and flight KING (Gilbert Islands), using special airborne (P2V) survey equipment (all times Zebra, March 1954, and readings extrapolated to the ground).

(1) NYOO Kwajalein Flight ABLE:

Atoll	DTG (Zebra)	Intensity (mr/hr)	Atoll	DTG (Zebra)	Intensity (mr/hr)
Lae	020010	.080	Ujae	020024	.100
Wotho	020100	1.000	Ailinginae	020128	400.000
Rongelap	020140	1350.000	Rongerik	020200	1720.000
*Taongi	020325	1.400	*Bikar	020428	600.000
Utirik	020451	240.000	*Taka	020456	160.000
Ailuk	020516	76.000	Jemo	020528	18.000
Likiep	020540	6.000			

* uninhabited

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(2) NYOO Kwajalein Flight BAKER:

Atoll	DTG (Zebra)	Intensity (mr/hr)	Atoll	DTG (Zebra)	Intensity (mr/hr)
Namu	021920	.020	Ailinglapalap	021945	.080
Namorik	030223	.200	Ebon	030047	.200
Kili	030024	.200	Jaluit	030006	.200
Mili	022309	.600	Arno	022228	.600
Majuro	022216	2.000	Aur	022145	.400
Maloelap	022124	3.600	Erikub	022102	4.000
Wotje	022051	20.000			

(3) NYOO Kwajalein Flight CHARLIE:

Kusaie	030100	.800	Pingelap	030005	.600
Mokil	022330	.600	Ponape	022145	.800
Ujelang	022015	.800			

(4) NYOO Guam Flight EASY:

Guam	052140	.000	Namonuito	060010	.000
Truk	060100	.000	Kuop	060110	.000
Losap	060135	.000	Namoluk	060200	.000
Lukunor	060215	.000	Satawan	060230	.000
Pulap	060404	.000	Guam	060615	.000

(5) NYOO Oahu Flight GEORGE:

Kauai	051740	.200	Niihau	051755	.080
Kaula	051805	.100	Nihoa	051857	.100
Necker	052000	.100	Fr. Frigate Shl.	052032	.200
Gardner Pinn.	052124	.200	Maro Reef	052225	.200
Laysan	052250	.080	Lisianski	052330	.080
Pearl-Hermes Rf.	060025	.080	Midway	060055	.100

(6) NYOO Oahu Flight ITEM:

Oahu	041718	.030	Lanai	041747	.004
Hawaii	041845	.040	Maui	042035	.080
Molokai	042115	.020			

(7) NYOO Gilbert Island Flight KING:

Beru	052305	.080	Nukunau	052315	.080
Arorae	052344	.040	Tamana	060015	.040
Onotoa	060028	.040	Tabiteuea	060047	.080
Aranuka	060135	.040	Abemama	—	.040
Tarawa	060229	.040	Abaiang	060239	.000
Marakei	060249	.000	Makin	060310	.080
Nonouti	060114	.080			

R. A. HOUSE
Lt Col USAF
Ch. Tech Br, J-3

H-72

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

MEMORANDUM FOR RECORD 1 May 1954

SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives (Prints distributed to following only: C/S, USA (ExAgt), DMA (AEC), DBM (AEC), HICOMTERPACIS, CINCPAC, CINCPACFLT, ChAFSWP, COMNAVSTAKWAJ)

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
1	4 Mar 54	Utirik	Trust Territory Representative and Interpreter arriving Utirik from Kwajalein to meet USS RENSHAW.
2	4 Mar 54	Utirik	RENSHAW receiving Utirik natives.
3	4 Mar 54	Utirik	Utirik natives on deck of RENSHAW.
4	4 Mar 54	Utirik	Similar
5	4 Mar 54	Utirik	Utirik Natives in whale boat.
7	4 Mar 54	Utirik	Feeding Utirik natives on RENSHAW.
8	4 Mar 54	Utirik	Utirik natives eating on deck of RENSHAW.
11	5 Mar 54	Kwajalein	RENSHAW arriving Kwajalein.
12	5 Mar 54	Kwajalein	Utirik natives being transported to compound.
22-1012	11 Mar 54	Rongelap	Whale boat coming onto Rongelap.
22-1013	11 Mar 54	Rongelap	Navy work party preparing gear to pull native boat onto beach.
22-1014	11 Mar 54	Rongelap	Native huts on Rongelap Island.
22-1015	11 Mar 54	Rongelap	Navy men pulling native boat onto beach.
22-1016	11 Mar 54	Rongelap	Similar, different angle.
22-1018	11 Mar 54	Rongelap	Whaleboat coming alongside USS NICHOLAS.
22-1019	11 Mar 54	Rongelap	Crew of NICHOLAS preparing to hoist whaleboat aboard.
22-1020	10 Mar 54	Sifo Island	Navy men taking native hut apart.
22-1021	10 Mar 54	Sifo Island	Mr. Strope taking sand sample from Sifo Island for radiation tests.
22-1022	10 Mar 54	Sifo Island	Men preparing native equipment for protection.

Incl 4

SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1023	10 Mar 54	Sifo Is.	Mr. Wilds, Dept of Interior representative placing native goods under cover for protection.
22-1024	10 Mar 54	Sifo Is.	Navy men cleaning native property before placing in tents.
22-1025	10 Mar 54	Sifo Is.	W. W. Baum climbing coconut tree to secure sample for radiation tests.
22-1026	10 Mar 54	Sifo Is.	Soule checking radiation of drying copra in tent area.
22-1027	10 Mar 54	Rongelap	Interior Rongelap School: Front-left.
22-1028	10 Mar 54	Rongelap	Same as above: Front-right.
22-1029	10 Mar 54	Rongelap	Exterior of Rongelap School.
22-1030	10 Mar 54	Rongerik	Reefer storage.
22-1031	10 Mar 54	Rongerik	Dumping spoiled food.
22-1032	10 Mar 54	Rongerik	Whaleboat survey party going ashore Eniwetak.
22-1033	10 Mar 54	Rongelap	Survey of native hut.
22-1034	3 Mar 54	Utirik	Aerial: Utirik Atoll from PBM.
22-1035	3 Mar 54	Utirik	Boy and old man on Utirik.
22-1036	3 Mar 54	Utirik	Village shot from lagoon.
22-1037	3 Mar 54	Utirik	Aerial of island.
22-1047	5 Mar 54	Kwajalein	Gen Clarkson with native women and children.
22-1049	5 Mar 54	Kwajalein	Gen Estes, Capt Sooy, Adm Clarke, Gen Clarkson talk to John, Magistrate of Rongelap, and Kabdo from Utirik.
22-1050	5 Mar 54	Kwajalein	Gen Clarkson, Adm Clarke, Kabdo, John.
22-1051	5 Mar 54	Kwajalein	USMC Band playing for natives at Naval dispensary.
22-1052	5 Mar 54	Kwajelain	Natives waiting for medics; Kabdo talks to Rud

Incl 4

SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1053	5 Mar 54	Kwajalein	T. Capelle and C. Rothrock, HMC, USN behind desk start medical record on Jinni and daughter, Alma
22-1054	5 Mar 54	Kwajalein	R. M. King, HM3 and M. L. Duncan, HM3 take blood samples from baby's toe, mother next right.
22-1055	5 Mar 54	Kwajalein	M. L. Duncan, R. M. King take blood sample from Utirik boy, mother next.
22-1056	5 Mar 54	Kwajalein	M. L. Duncan takes sample of blood from Utirik man.
22-1057	5 Mar 54	Kwajalein	Similar, different native man.
22-1058	5 Mar 54	Kwajalein	W. E. Rice, HMC, making blood count at microscope.
22-1059	5 Mar 54	Kwajalein	L. W. Kraushaar, HM2, preparing blood sample for a cell count.
22-1060	5 Mar 54	Kwajalein	Similar, different angle.
22-1061	5 Mar 54	Kwajalein	Utirik mother bottle feeding baby at dispensary.
22-1062	5 Mar 54	Kwajalein	Marshallese waiting turn for finger-prick at dispensary.
22-1063	5 Mar 54	Kwajalein	HM2 Kraushaar, getting blood sample from elderly Utirik man.
22-1064	5 Mar 54	Kwajalein	Procedure meeting of Native Aid Operation; left to right: Adm Clarke, Lt Bowman, O. DeBrum, M. Wilds, Cdr E.F. Grable, Lt Guna, Lcdr R.D. Halpin, Cdr W.J. Hall, Cdr Blasdel, Capt D.A. Sooy.
22-1066	5 Mar 54	Kwajalein	Native women prepare fruits.
22-1067	5 Mar 54	Kwajalein	L.V. DeJong issuing soap for natives' decontamination baths in lagoon.
22-1068	5 Mar 54	Kwajalein	Male natives taking decontamination baths in lagoon.
22-1069	5 Mar 54	Kwajalein	LS: Native compound at Kwajalein.
22-1070	5 Mar 54	Kwajalein	Marshallese Church Service.

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INCL 4

SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1071	5 Mar 54	Kwajalein	Natives leaving Church Service.
22-1072	5 Mar 54	Kwajalein	CWOHC H.J. Spangler with native boy at dispensary.
22-1073	5 Mar 54	Kwajalein	Drs. Cdr W.J. Hall, Capt DeMent, Lt J.S. Thompson.
22-1074	5 Mar 54	Kwajalein	Native women prepare for decontamination bath.
22-1075	5 Mar 54	Kwajalein	Similar: LS: Island background (DeJong issuing soap).
22-1076	5 Mar 54	Kwajalein	Similar: LS: Lagoon background (DeJong issuing soap).
22-1077	5 Mar 54	Kwajalein	Decontamination bath: Mother with baby in lagoon.
22-1078	5 Mar 54	Kwajalein	Kabdo and wife (Utirik) in compound.
22-1079	5 Mar 54	Kwajalein	Utirik man with children in compound.
22-1080	5 Mar 54	Kwajalein	Native mother with baby drinking coconut.
22-1081	5 Mar 54	Kwajalein	Native father with baby drinking coconut.
22-1082	5 Mar 54	Kwajalein	V.C. Eberle playing with native kids.
22-1083	5 Mar 54	Kwajalein	W.W. Naylor, DC2, W.E. VanNattan, AO3, CWO L.G. Barr, J.C. Westbrook, AK1: Monitor team.
22-1084	5 Mar 54	Kwajalein	Drs. Lt Thompson, Capt DeMent, Gordon Dunning.
22-1085	5 Mar 54	Kwajalein	Westbrook monitoring native woman with baby.
22-1086	5 Mar 54	Kwajalein	Westbrook monitoring young native girl.
22-1087	5 Mar 54	Kwajalein	DeJong and Westbrook monitor native men and boys.
22-1088	5 Mar 54	Kwajalein	L.V. DeJong monitoring young boy.
22-1089	5 Mar 54	Kwajalein	Naylor and VanNattan monitor native man.
22-1090	5 Mar 54	Kwajalein	Sailors monitor native man with baby.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1091	5 Mar 54	Kwajalein	Sailors monitor natives at compound.
22-1092	5 Mar 54	Kwajalein	Naylor and VanNattan read native boy's foot.
22-1093	5 Mar 54	Kwajalein	DeJone reading lady's hair (geiger)
22-1094	11 Mar 54	Kwajalein	King John (Rongelap) talking to Drs. Dunning, DeMent, Hall and Mr. O. DeBrun.
22-1095	11 Mar 54	Kwajalein	Drs. Dunning, DeMent, unknown, Hall, unknown.
22-1097	11 Mar 54	Kwajalein	Sailors play hopscotch with native kids.
22-1098	11 Mar 54	Kwajalein	Taking chow to native mess (from truck).
22-1099	11 Mar 54	Kwajalein	Natives in chow line. Sailors serving.
22-1100	11 Mar 54	Kwajalein	USMC Band playing for Marshallese.
22-1101	11 Mar 54	Kwajalein	Similar to 22-1100.
22-1102	11 Mar 54	Kwajalein	Native barber giving haircuts.
22-1103	11 Mar 54	Kwajalein	Ensign Peters and Mr. Evans (ARC) with handout items.
22-1104	11 Mar 54	Kwajalein	Peters and Evans handing out ARC items to natives.
22-1105	11 Mar 54	Kwajalein	Similar to 22-1104.
22-1106	11 Mar 54	Kwajalein	Lt Marcella (nurse) with Dr. DeMent, Capt, USN.
22-1107	11 Mar 54	Kwajalein	Peters and Evans giving candy to native kids.
22-1108	11 Mar 54	Kwajalein	Marshallese playing volley-ball.
22-1109	11 Mar 54	Kwajalein	Peters and Evans unwrapping candy, etc. for natives.
22-1110	11 Mar 54	Kwajalein	J.C. Westbrook with monitor and Dr. DeMent check natives' hair after decontamination wash. Ensigns Johnson and Peters look on.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1111	11 Mar 54	Kwajalein	Navy wives donate clothes to Marshallese; left to right: Mrs. C.E. McLanahan, Mrs. R.S. Clarke, Mrs. W.H. Shannon, and Mrs. A.L. Howe.
22-1112	11 Mar 54	Kwajalein	Jack Tobin (District Anthropologist) with Rongelap Magistrate John and Utirik's Komboj.
22-1114	11 Mar 54	Kwajalein	Nurse (Lt) Marcella Smith, Dr. (Lt) J.S. Thompson, and Jabwe (native doctor) and Ellen.
22-1115	11 Mar 54	Kwajalein	W.E. VanNattan and W.W. Naylor monitoring native clothing in laundry.
22-1116	3 Mar 54	Utirik	Utirik Atoll before evacuation. Natives in foreground, 1stLt W.J. Larson, USAF, (Instrumentation Officer) and Ens R.P. Keiser, USNR, arriving in rubber boat. Seaplane in background.
22-1117	3 Mar 54	Utirik	Native colony on Utirik Atoll.
22-1118	3 Mar 54	Utirik	Similar, beach scene.
22-1119	3 Mar 54	Utirik	Similar, native house.
22-1120	3 Mar 54	Utirik	Outrigger and native paddling toward native colony at Utirik.
22-1121	3 Mar 54	Utirik	Native colony from lagoon - Utirik.
22-1122	3 Mar 54	Utirik	1stLt W.J. Larson getting soil samples, native colony in background.
22-1123	3 Mar 54	Utirik	Similar.
22-1204	20 Mar 54	Kwajalein	Dr. Conard examining Jemlok, 2 years, bald from BRAVO shot contamination.
22-1205	20 Mar 54	Kwajalein	Dr. Conard examining neck rash on Jimako.
22-1206	20 Mar 54	Kwajalein	Left to right: Dr. Conard, natives, Mahaffey, Evans and Pratt set for still photo.
22-1207	20 Mar 54	Kwajalein	Group shot of native children.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1208	20 Mar 54	Kwajalein	Portrait of Chief Magistrate of Rongelap, John.
22-1209	20 Mar 54	Kwajalein	Weather station personnel being examined by Dr. Conard.
22-1210	20 Mar 54	Kwajalein	Dr. V. Bond examining hair of Smith.
22-1211	20 Mar 54	Kwajalein	Group shot of weather station personnel subjected to fallout from BRAVO: left to right: Seated, A/1C R. Harmer, S/Sgt L. Winchester, A/1C R. Pettingill, A/1C B. Andrews, A/2C D. Black, A/1C W. Smith, A/1C L. Bushkin; standing: A/1C. D. Baker A/1C J. Ashby, S/Sgt C. Townsend, M/Sgt R. Pletsch, A/1C Azbill, A/1C. R. Roper, A/1C Curbow, WOJG J. Kapral, S/Sgt A. Campbell.
22-1212	20 Mar 54	Kwajalein	Native children eating lunch.
22-1213	20 Mar 54	Kwajalein	Adults and children eating lunch.
22-1214	20 Mar 54	Kwajalein	Similar to 1213.
22-1215	20 Mar 54	Kwajalein	Similar to 1213.
22-1216	20 Mar 54	Kwajalein	Similar to 1213.
22-1219	20 Mar 54	Kwajalein	Dr. Conard examining natives.
22-1220	20 Mar 54	Kwajalein	Similar.
22-1221	20 Mar 54	Kwajalein	Left to right: Dr. Conard, Marta, Jonita and Biliet (interpreter) - examination.
22-1222	20 Mar 54	Kwajalein	Left to right: Mahaffey, Evans, Dr. Conard, Pratt with natives at examination.
22-1223	20 Mar 54	Kwajalein	Dr. Conard and George Pratt discuss shot of native examination, camera in background.
22-1224	20 Mar 54	Kwajalein	Dr. Conard examining back of neck of native.
22-1225	10 Mar 54	Rongerik (Eniwetak Is)	Radsafe man checking tent (ionisphere recording station) for radiation level.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1235	10 Mar 54	Eniwetak Is	Navy man holding sick rat (radiation) at Eniwetak main camp.
22-1237	8 Mar 54	Rongelap	Native workshed along beach.
22-1238	8 Mar 54	Rongelap	Interior of native home.
22-1239	8 Mar 54	Rongelap	Similar.
22-1240	8 Mar 54	Rongelap	Radsafe man checking outrigger canoe for fallout radiation.
22-1241	8 Mar 54	Rongelap	Similar.
22-1242	8 Mar 54	Rongelap	Beach scene of Rongelap.
22-1243	8 Mar 54	Rongelap	Left to right: Mr. M.E. Wilds (Department of Interior Representative) and Lt Fink, Executive Officer of USS NICHOLAS talking to destroyer by radio.
22-1244	8 Mar 54	Rongelap	Radsafe man checking native cemetary for radiation.
22-1245	8 Mar 54	Rongelap	Similar to 22-1244.
22-1246	8 Mar 54	Rongelap	Typical native house in main part of village.
22-1258	8 Mar 54	Rongelap	Pigs left at village after evacuation.
22-1260	8 Mar 54	Rongelap	Chickens left behind by natives.
22-1261	8 Mar 54	Rongelap	M.E. Wilds sitting in whaleboat.
22-1262	8 Mar 54	Rongelap	Dr. Scoville sitting in whaleboat.
22-1263	8 Mar 54	Rongelap	Whaleboat anchored in lagoon.
22-1264	8 Mar 54	Rongelap	Two whaleboats together in lagoon for conference on procedure.
22-1265	8 Mar 54	Rongelap	Whaleboat underway in lagoon.
22-1266	8 Mar 54	Rongerik	Navy personnel examining mess hall at main camp on Eniwetak Island.
22-1267	8 Mar 54	Rongerik	Similar, different view in mess hall.
22-1268	8 Mar 54	Rongerik	Interior of reefer.
22-1269	8 Mar 54	Rongerik	Similar.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1270	8 Mar 54	Rongerik	Interior of dispensary on Eniwetak.
22-1271	8 Mar 54	Rongerik	Similar.
22-1272	8 Mar 54	Rongerik	Interior of supply room on Eniwetak.
22-1273	8 Mar 54	Rongerik	Similar.
22-1274	8 Mar 54	Rongerik	Interior of living quarters on Eniwetak.
22-1275	8 Mar 54	Rongerik	Similar, different angle.
22-1276	8 Mar 54	Rongerik	Similar.
22-1277	8 Mar 54	Rongerik	Similar.
22-1278	8 Mar 54	Utirik	Beach scene in front of village.
22-1278	8 Mar 54	Utirik	View along main path in Utirik village.
22-1280	8 Mar 54	Utirik	Village scene, Utirik.
22-1281	8 Mar 54	Utirik	Main path looking away from village.
22-1282	8 Mar 54	Utirik	Native home outside main part of village.
22-1283	8 Mar 54	Utirik	Outrigger canoes along beach near village.
22-1284	8 Mar 54	Utirik	Men loading radiation samples in whaleboat on Utirik beach.
22-1285	8 Mar 54	Utirik	Whaleboat being raised aboard USS NICHOLAS
22-1287	8 Mar 54	Utirik	Radsafe man checking Dr. Scoville.
22-1288	9 Mar 54	Rongerik	Men in main camp on Eniwetak.
22-1290	9 Mar 54	Rongelap	Radsafe men landing on Rongelap beach from whaleboat.
22-1291	9 Mar 54	Rongelap	Radsafe men talking in village on Rongelap
22-1292	9 Mar 54	Rongelap	Similar.
22-1293	9 Mar 54	Rongelap	Burned Church at Rongelap village.
22-1294	9 Mar 54	Rongelap	Similar, different angle.
22-1295	9 Mar 54	Rongelap	Native wash house in Rongelap village.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1296	9 Mar 54	Rongelap	Rongelap village scene.
22-1297	9 Mar 54	Rongelap	Abandoned goose on Rongelap beach.
22-1298	20 Mar 54	Kwajalein	Dr. Cronkite examining King Ian of Utirik
22-1299	20 Mar 54	Kwajalein	Similar.
22-1300	20 Mar 54	Kwajalein	Similar.
22-1301	20 Mar 54	Kwajalein	Similar.
22-1302	20 Mar 54	Kwajalein	Native people of Utirik watching examination.
22-1303	20 Mar 54	Kwajalein	Two typical native women and two girls.
22-1304	20 Mar 54	Kwajalein	Natives watching examination.
22-1305	20 Mar 54	Kwajalein	Dr. Conard behind natives watching exmination.
22-1306	20 Mar 54	Kwajalein	Dr. Cronkite examining native girl's mouth.
22-1307	20 Mar 54	Kwajalein	Dr. Cronkite examining native boy's hair.
22-1308	20 Mar 54	Kwajalein	Portrait of King Ian of Utirik.
22-1309	20 Mar 54	Kwajalein	Group shot of George Pratt, King Ian, Dr. Cronkite and King Ian's wife.
22-1310	20 Mar 54	Kwajalein	TU-8 photographer photographing natives for identification purposes.
22-1311	20 Mar 54	Kwajalein	Similar.
22-1312	20 Mar 54	Kwajalein	Similar.
22-1313	20 Mar 54	Kwajalein	Interior of hospital, nurse Kathleen Emil treating ear sore of Tima, Dr. Shulman in background.
22-1314	20 Mar 54	Kwajalein	Similar, Dr. Shulman treating Tima.
22-1315	20 Mar 54	Kwajalein	Similar.
22-1316	20 Mar 54	Kwajalein	Native children treated for anal cracks.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1317	20 Mar 54	Kwajalein	Similar
22-1318	20 Mar 54	Kwajalein	Native medic treating mouth of native child.
22-1319	20 Mar 54	Kwajalein	Dr. Shulman treating eye of Naimira.
22-1320	20 Mar 54	Kwajalein	Native medic treating anus of native child.
22-1321	20 Mar 54	Kwajalein	Dr. Shulman treating neck sore on Timako, Nurse Emil assisting.
22-1322	20 Mar 54	Kwajalein	Similar.
22-1323	20 Mar 54	Kwajalein	Similar.
22-1324	20 Mar 54	Kwajalein	Similar.
22-1325	20 Mar 54	Kwajalein	Taking blood sample from Airman Lagna.
22-1326	20 Mar 54	Kwajalein	Similar.
22-1327	20 Mar 54	Kwajalein	Taking blood samples from weather station airman.
22-1328	20 Mar 54	Kwajalein	Dr. V. Bond taking blood sample from Bertalino.
22-1329	20 Mar 54	Kwajalein	Similar to 22-1328.
22-1330	20 Mar 54	Kwajalein	Similar, different airman.
22-1331	20 Mar 54	Kwajalein	Blood testing and counting room.
22-1332	20 Mar 54	Kwajalein	Similar, different view.
22-1333	20 Mar 54	Kwajalein	Similar, different view.
22-1334	20 Mar 54	Kwajalein	Dr. V. Bond taking blood samples from native.
22-1335	20 Mar 54	Kwajalein	Similar, different angle.
22-1336	20 Mar 54	Kwajalein	Similar, but samples from women.
22-1337	20 Mar 54	Kwajalein	Similar.
22-1338	20 Mar 54	Kwajalein	Similar.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1339	20 Mar 54	Kwajalein	Dr. Cronkite and Dr. Bond talking to native child.
22-1340	20 Mar 54	Kwajalein	Native watching examination.
22-1341	20 Mar 54	Kwajalein	Similar, but with Dr. Bond in group.
22-1342	20 Mar 54	Kwajalein	Dr. Cronkite and Dr. Bond examining native child.
22-1343	20 Mar 54	Kwajalein	Dr. Cronkite examining native child.
22-1344	20 Mar 54	Kwajalein	Dr. Cronkite examining native baby on lap of father.
22-1345	20 Mar 54	Kwajalein	Closeup of native father and baby. Dr. Cronkite examining baby.
22-1346	20 Mar 54	Kwajalein	Closeup of native father and baby.
22-1347	20 Mar 54	Kwajalein	Closeup of King Ian of Utirik.
22-1348	20 Mar 54	Kwajalein	Similar.
22-1349	20 Mar 54	Kwajalein	King Ian, wife and son.
22-1350	20 Mar 54	Kwajalein	King Ian, wife and two sons.
22-1363	10 Mar 54	Rongerik Atoll (Eniwetak Is)	Men unloading spoiled food from reefer.
22-1364	10 Mar 54	Eniwetak Is	Men loading spoiled food onto truck.
22-1365	10 Mar 54	Eniwetak Is	Similar to 22-1363.
22-1366	10 Mar 54	Eniwetak Is	Men loading spoiled food onto truck.
22-1367	10 Mar 54	Eniwetak Is	Backing truck onto reef to dispose of spoiled food.
22-1368	10 Mar 54	Eniwetak Is	Men dumping spoiled food on reef.
22-1369	10 Mar 54	Ailinginae Atoll	Native cooking area on Sifo Island.
22-1370	10 Mar 54	Sifo Island	Interior of native tent.
22-1371	20 Mar 54	Kwajalein	Natives waiting for blood sample taking at dispensary.

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SUBJECT: Black and White Contact Prints Relative to Surveys, Evacuation and Care of Rongelap and Utirik Natives

PHOTO NO.	DATE TAKEN	LOCATION	CAPTION
22-1372	20 Mar 54	Kwajalcin	Similar, but with nativo woman and child.
22-1377	20 Mar 54	Kwajalcin	Nativo being fed.
22-1378	20 Mar 54	Kwajalcin	Similar.
22-1379	20 Mar 54	Kwajalcin	Rod Cross Field man, Mr. Evans, distributing gum to natives.
22-1380	20 Mar 54	Kwajalein	Nativo man shaving himsolf with safoty razor blado.
22-1381	20 Mar 54	Kwajalein	CWOHC J.J. Spanglor with nativo boy at dispensary.
22-1382	20 Mar 54	Kwajalcin	Navy radsafe man chocking nativos.
22-1383	20 Mar 54	Kwajalcin	Closeup of radsafe man and radiation counter reading foot of native.
22-1384	20 Mar 54	Kwajalcin	Nativo children playing hop scotch.

(s/t) R. A. HOUSE
LtCol, USAF
ChTochOpns Br, J-3 & Radsafe Officor

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HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

J-3/141.8 1 May 1954

SUBJECT: Survey of Rongelap and Utirik Atolls

TO: Commander in Chief, Pacific
Navy No. 128, c/o Fleet Post Office
San Francisco, California

1. Forwarded herewith is the report of the survey party which visited Rongelap and Utirik Atolls during the period 21-23 April, in order to determine what action must be taken prior to return of the native populations to these places.

2. I concur in the recommendations submitted. I recommend that you designate as soon as possible your representative who will coordinate the activities of interested agencies in this project. I assure you that the personnel and facilities of Joint Task Force SEVEN will be made available to your Project Officer as long as elements of the Task Force remain in the Forward Area.

3. When I am advised of your approval of the recommendations contained in this report, additional copies will be reproduced here and forwarded to interested agencies for their use.

/s/ P W Clarkson
P. W. CLARKSON
Major General, USA
Commander

1 Incl
Report of Survey of Rongelap and Utirik Atolls (in dup)

A CERTIFIED TRUE COPY:

Robert Chesney
ROBERT CHESNEY
Major USAF
Adjutant General

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HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

30 April 1954

SUBJECT: Survey of Rongelap and Utirik Atolls

THRU: Commander, Joint Task Force SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

TO: Commander in Chief, Pacific
Navy No. 128, c/o Fleet Post Office
San Francisco, California

1. References:

a. Letter, CJTF SEVEN to CINCPAC dated 9 April 1954, subject: "Return of Inhabitants of Rongelap and Utirik to their Home Atolls".

b, Message, CINCPAC to CJTF SEVEN, 140042Z April 1954.

c. Message, CINCPAC to CNO, 160501Z April 1954.

2. In accordance with the provisions of references a and b, a survey party visited Rongelap and Utirik Atolls during the period 21-23 April 1954. The mission of the survey party was to determine what action must be taken prior to the return of the native population to these atolls, from which they were evacuated early in March 1954 as a consequence of the initial detonation of the CASTLE test series. The composition of the survey party is indicated in Inclosure 1. A narrative account of the activities of the survey party, including observations concerning the two atolls, is presented in Inclosure 2.

3. In general, the conclusions of the survey party confirmed the planning factors outlined in reference a. The natives of Utirik Atoll may be returned to their homes shortly after the last shot of the CASTLE series. On the other hand, the natives of Rongelap Atoll can not be returned to their homes for approximately one year. 1 May 1955 is recommended as the planning date for the return to Rongelap. The natives of Rongelap should be examined periodically to monitor their recovery from

the effects of the radiation received, and Rongelap Atoll should be visited quarterly by RadSafe personnel to monitor the decay of the contamination there.

4. The survey party submits the following specific recommendations:

a. UTIRIK

(1) Several days after the last CASTLE shot, Utirik Atoll should be inspected again by RadSafe personnel of JTF SEVEN or AEC to determine whether or not additional contamination has occurred. If no increase in external radiation and food and water contamination levels is noted, the return of the natives may be undertaken without delay. The contamination levels now present at the two atolls are indicated in Inclosure 3. Research analysis of the foods and water collected is being made by NRDL and NYOO.

(2) CINCPACFLT should designate a project officer to coordinate the activities of interested agencies in the return of the Utirik natives.

(3) CINCPACFLT should designate and make available a ship which will transport the Utirik natives and their belongings from Kwajalein back to Utirik. In addition to the few personal effects the natives have with them, the following items should be moved to Utirik. These items should be assembled by the CINCPACFLT project officer in coordination with the local Kwajalein representative of TERPACIS, and the funds for necessary purchases should be provided by JTF SEVEN:

(a) Used lumber, already made available by ComNavSta Kwajalein.

(b) Flour, salt and other staple items of food supplies adequate for one month.

(c) Limited amounts of nails, window glass, metal roofing and medical supplies as determined by CINCPACFLT project officer in coordination with Kwajalein representative of TERPACIS.

(d) 10,000 gallons of fresh water to flush and refill Utirik cisterns.

(e) Approximately 400 chickens, 120 pigs and small numbers of other animals as determined by CINCPACFLT project officer, in coordination with TERPACIS rep-

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resentative. Some of these animals are already being obtained by the TERPACIS representatives at Kwajalein.

(4) The survey party was advised that on a number of occasions LSTs have entered the Utirik lagoon. The use of this type ship is recommended, if the CINCPACFLT project officer concurs after investigation of the lagoon channels.

(5) No construction or repair work by U.S. personnel is required, since little deterioration of the buildings on Utirik has occurred since the evacuation.

(6) No decontamination work is required, except for the flushing and cleaning of cisterns recommended above.

b. RONGELAP

(1) The natives of Rongelap Atoll should be relocated on an island of the Kwajalein Atoll for the period of approximately one year. BIKEJ Island has been selected by TERPACIS representatives at Kwajalein for this purpose. This island is under control of TERPACIS. COMNAVSTAKWAJ concurs in this selection. The relocation near NAVSTA Kwajalein is in accord with the recommendations of the Project Officer of Project 4.1, who will shortly conclude the active medical surveillance of the Rongelap natives at Kwajalein.

(2) As in the case of the Utirik natives, CINCPACFLT should designate a project officer to coordinate the activities of interested agencies during the temporary relocation of Rongelap natives and during their ultimate return to their homes.

(3) The temporary nature of this relocation should be given wide publicity throughout the Trust Territories and U.S. news media, after the movement has been completed.

(4) The AEC contractor at the Pacific Proving Grounds (Holmes and Narver, Inc.) should prefabricate as necessary and supervise the construction of small wood dwellings, a combination school and church, a dispensary, and other buildings and cisterns for the 82 Rongelap natives to be relocated temporarily in the Kwajalein Atoll. Materials for this construction will be provided from Eniwetok and delivered to the site of the new village by JTF SEVEN. Details of the construction required are presented in Inclosure 4.

(5) Common labor for this construction should be provided by the natives of Rongelap themselves, as much as possible. Holmes and Narver personnel will perform the more difficult tasks. Native labor should be paid wages by JTF SEVEN at a wage scale determined by the representatives of TERPACIS.

(6) Water and staple food supplies for one month should be provided initially, as in the case of the Utirik natives covered above. Likewise, chickens and animals should be provided in numbers determined by representatives of TERPACIS and the CINCPACFLT project officer. In addition, the Rongelap natives must be provided minimum food supplies and other essentials on a continuing basis, since they will have no income from sale of copra and since BIKEJ Island provides meager quantities of natural foods.

(7) Just prior to the time the Rongelap natives are moved from Kwajalein Island to BIKEJ Island, a ship should be sent to Rongelap Island to pick up the clothing, books and other belongings (including two 30-foot [illegible] of the natives. Decontamination of these items should be performed at Kwajalein under supervision of local or JTF SEVEN RadSafe personnel.

(8) Periodic medical surveys of the natives and RadSafe surveys of the atolls should be conducted by qualified personnel operating out of NavSta Kwajalein. Dr. Bugher, DBM, AEC, stated that his office would periodically send groups of qualified personnel to Kwajalein for this purpose.

(9) AEC RadSafe personnel resident in the Pacific Proving Grounds, in conjunction with representatives of DBM, AEC, should make periodic inspections of the islands of Rongelap Atoll to ascertain the rate of decay of the contamination. Reports of these inspections should be forwarded to interested agencies; AEC, CINCPACFLT, JTF SEVEN, COMNAVSTA KWAJALEIN.

(10) A representative of CINCPACFLT, probably COMNAVSTAKWAJ, should monitor the general welfare of the Rongelap natives during their temporary stay at Kwajalein Atoll.

(11) In the spring of 1955, another survey party should visit the islands of Rongelap Atoll and the natives in their temporary homes at Kwajalein Atoll to determine when these natives may be returned to their homes and what additional action must be taken prior to their movement form Kwajalein Atoll. The same agencies should be represented on this later survey party as on this group. Funds required for this movement and the construction and supplies necessary at Rongelap Island will be provided by JTF SEVEN.

SUBJECT: Survey of Rongelap and Utirik Atolls.

5. All members of the survey party agree on the recommendations presented. CDR E. P. CRONKITE, Project Officer of Project 4.1 was not a member of the survey party, but he was consulted several times. His views were considered by the survey party. All data from the testing of soil, water and food items will not be available and evaluated for some weeks.

6. Finally, the survey party emphasizes the importance of publicizing the temporary nature of the relocation. It is possible that the natives will be content to remain at Kwajalein Atoll after they live there a year, under subsidy of the U.S. Government. Mr. Neas, District Administrator of TERPACIS at Majuro, stated at a conference at Kwajalein on 27 April 1954 that it is the policy of TERPACIS to discourage concentration of Marshallese natives at a few commercially favorable locations and to discourage too rapid acquisition of wealth by small groups of natives. This policy confirms the recommendation made above that the subsidy provided the natives while at Kwajalein be held to the essential minimum.

4 Incls:
1. Composition of Survey Party.
2. Narrative Account of Activities of Survey Party.
3. Radiological Surveys of Rongelap and Utirik Atolls.
4. Construction Required to Establish Temporary Village for Rongelap Natives.

DAVID O. BYARS, JR.
Colonel, U. S. Army
Senior Member

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COMPOSITION OF SURVEY PARTY
WHICH VISITED RONGELAP AND UTIRIK ATOLLS, 21-23 APRIL 1954

Name	Organization	Function
Colonel David O. Byars, Jr. U.S. Army	Hq, JTF SEVEN	Senior Member
Dr. Thomas White	Advisor to CTG 7.1 on RadSafe Matters	RadSafe, health and decontamination
Mr. James G. Terrill, Jr.	Advisor from Public Health Service to CTG 7.1	RadSafe, health and decontamination
Captain William Home U.S. Army	Ass't RadSafe Advisor to TG 7.1 from Army Chemical Center	RadSafe, health and decontamination
Mr. David L. Narver, Jr.	Project Engineer, Holmes & Narver, Inc.	AEC contractor for repair and construction required
Mr. Charles Embree	Ass't Resident Engr., Holmes & Narver, Inc.	"
Mr. Charles W. Kelley, Jr.	Ass't Project Mgr., Holmes & Narver, Inc.	"
Mr. Marion Wilds	Representative of District Administrator, TERPACIS, at Kwajalein (Ebeye)	Represent HICOMTERPACIS and interests of the natives
LCDR Robert W. Wells, U.S. Navy	Legal Officer, U.S. Naval Station at Kwajalein	Represent CINCPACFLT
Mr. Douglas Dare	Task Unit 9, TG 7.1	Cameraman
Sgt William W. Baum, U.S. Air Force	Task Unit 9, TG 7.1	Photographer
LT W. H. Chapman U.S. Navy	Project 4.1, Naval Medical Research Institute	Collect samples of soil, water and food for test
John	Rongelap	Atoll Magistrate
Nicodemus	Rongelap	Native
Jabwe	Rongelap	Native

Name	Organization	Function
Compass	Utirik	Atoll Magistrate
Kabwodwod	Utirik	Native
Saul	Utirik	Native

INCLOSURE NO. 1

H.93

HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

30 April 1954

NARRATIVE OF ACTIVITIES OF SURVEY PARTY ON VISIT TO RONGELAP AND UTIRIK ATOLLS

19 April - The members of the survey party who are normally based at Eniwetok during Operation CASTLE proceeded to Kwajalein by C-47 aircraft.

20 April - The survey party assembled in the office of RADM Clarke, COMNAVSTAKWAJ, at 1000 hours. In addition to the survey party and ADM Clarke, Dr. John Bugher, Director of Division of Biology and Medicine of the AEC, and Mr. Jack Tobin, District Anthropologist of TERPACIS, were present. Col Byars outlined the purpose and schedule of the trip. Mr. Tobin translated for the natives present. The possibility of having to relocate temporarily the Rongelap natives was discussed briefly. The conference adjourned at 1100 hours. After the conference, Mr. Tobin and Mr. Wilds representing TERPACIS stated that the natives were very glad to learn that definite action is being initiated to return them to their homes.

In the afternoon, membérs of the survey party and Dr. Bugher visited the office of Project 4.1 and discussed the work of that unit with the Project Officer, CDR E. P. Cronkite. This unit works directly across the street from the barracks in which the 82 natives of Rongelap are billeted. Project 4.1 has conducted extensive tests of evacuated natives, and results of the work will be made available to interested agencies.

At 1600 hours the survey party boarded the USS PHILLIP (DDE 498), which sailed from Kwajalein at 1800 hours.

21 April - The PHILIP entered the lagoon of Rongelap Atoll at 0700 hours and anchored off the beach of Rongelap Island. The entire party went ashore in motor whaleboats and began a survey of the island. Chickens were seized without delay. No other animals or domestic fowls were observed, except several cats. The three natives from Rongelap assisted the survey party in identifying buildings, locating cisterns and wells, and answering questions. All six natives were active in the collection of chickens and soil, water and food samples. The Rongelap natives transported to the PHILIP sewing machines and other personal effects from the dwellings.

22 April - The survey party was divided into two groups. One group returned to Rongelap Island and continued the survey of the native village. The other group proceeded by motor whaleboat to three islands of the Rongelap Atoll north of Rongelap Island. These islands were Busch,

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Enialo and Eniaetok. Radiation levels were recorded on the three islands; the intensity increased as the party moved northward, as was expected. Actual readings are presented in Inclosure No. 3. On Enialo Island, birds eggs were gathered for testing since the natives include these in their diet.

Dr. White conducted an experiment on Rongelap Island in which he used fire-fighting equipment from the PHILIP to wash down the thatch roof of one of the native buildings. After a considerable drenching the intensity of the roof was reduced by ten percent, as some of the contamination was washed off the roof onto the ground.

Members of the ship's company were spearfishing in the afternoon and donated their catch to the collection of food samples which will be tested.

The survey of Rongelap was concluded and the party returned to the PHILIP. Certain general observations were presented in regard to the current situation at Rongelap:

1. The present intensity of radiation on Rongelap Island is 15-20 milliroentgens per hour (mr/hr).

2. Little damage to buildings on Rongelap has occurred since the evacuation. The Rongelap natives confirmed this. However, heavy rains or storms during the year or more that the natives will be absent will probably cause considerable damage. An estimate of the repairs necessary for the return of the population must be based on a survey made just prior to this return.

3. The survey party was impressed with the primitiveness of the dwellings. The buildings were walled with woven panels of scrap lumber and were invariably roofed with thatch. The natives sleep on mats which are laid on bare wood floors or directly on the ground. No other furniture is present in the sleeping dwellings except a few wood boxes for storing clothes in each room. The families eat in adjacent buildings or outside. The evacuation of the remainder of the household effects of the 82 Rongelap natives will not present much of a problem.

4. The only building in the village which showed the work of skilled carpentry was the church. However, this edifice had burned shortly before 1 March.

5. The water supply is precarious. There are six concrete cisterns in the village. These cisterns are concrete boxes about five feet on a side. The rain falling on the tin roofs of the cisterns is collected by draining it through gutters into the boxes. Four of the six cisterns contained water, of which samples were taken for testing.

6. A village can be constructed with little effort by Holmes & Narver at another location for the temporary residence of the Rongelap natives which will be at least as comfortable and sanitary as the present Rongelap village.

7. LSTs will have no difficulty in entering the Rongelap lagoon and beaching at the village.

8. The items collected at Rongelap Island for testing included cocoanuts, pandanus fruit, papayas, water (cistern and well), soil (surface and from three inches under surface), pumpkin, eggs, fish, clams, 12 chickens, and arrowroot. These items afford a good cross section of the diet of the Rongelap residents.

9. There were few food supplies noted. There was a small store, but its shelves were bare. The dwellings contained almost no food items.

23 April - Again the survey party was divided into two parts. One group flew to Utirik Atoll, surveyed the conditions there and returned to Rongelap Atoll lagoon. The other group moved on the PHILIP to Ailinginae Atoll. The destroyer stood off the southern side of the atoll and dispatched motor whaleboats to Sifo and Enibuk Islands.

At Sifo certain equipment left there by members of Task Group 7.1 was recovered. Also, the camp used by the natives from Rongelap was inspected. Sifo will not be satisfactory as a site for the temporary relocation of the Rongelap natives. The natives do not wish to go there; it is inaccessible to medical facilities; and the current radiation levels are 6 MR/HR. At Enibuk Island the crew of the PHILIP assisted the natives in moving the 30-foot sloop onto the beach. The PHILIP returned to Rongelap Atoll lagoon and arrived just as the SA-16 returned from Utirik. The group from the SA-16 aircraft and the samples taken from Utirik were taken aboard the PHILIP, which sailed at 1830 hours for Kwajalein.

The other group of the survey party visited Utirik during the day. The eight members of the party who made the flight to Utirik were: Colonel Byars, Mr. Terrill, Mr. Kelley, Mr. Wilds, Lt Chapman, Mr. Dare, Native Magistrate Compass, and Native Kabwodwod. An SA-16 aircraft from Eniwetok landed in the lagoon at Rongelap, took aboard the survey group, and took off for Utirik at 0830.

The SA-16 landed at Utirik at 1000 hours. There are many coral heads in the lagoon just under the surface of the water, but the pilot of the SA-16 was able to land without difficulty. The survey group moved to and from the beach in the six-man rubber life raft from the aircraft.

The following general observations concerning Utirik are submitted: Details of the current contamination levels are presented in Inclosure No. 3:

1. The village at Utirik is a similar to but larger than the village at Rongelap. Utirik is the only inhabited island in the atoll. The island is more productive than Rongelap; papayas, pandanus, and bread fruit grow abundantly. The houses and cisterns were somewhat better than those at Rongelap.

2. Three pigs were taken for testing. Several wild dogs were seen but were not captured. If any of these dogs are still alive when the natives return, the dogs must be destroyed. The dogs have killed all the chickens abandoned at the time of the evacuation.

3. According to the natives, LSTs have beached at the village, despite narrow passage into the lagoon and the coral heads there.

4. The following items were removed from Utirik for testing; cocoanuts, pandanus fruit, papayas, grass, water, soil, three pigs, bread fruit, and arrowroot.

The survey group returned to the SA-16 and departed from Utirik at 1515 hours. The group returned to the PHILIP at Rongelap and the destroyer got underway at 1830 hours.

24 April - The PHILIP docked at Kwajalein at 0800 hours. The survey party, less the natives, moved to the Guest House where a conference was conducted at 1000 hours. Mr. Tobin, District Anthropologist for TERPACIS, was also present. The results of the survey trip were discussed and plans for the drafting of this report were made.

The members of the survey party who are stationed at Eniwetok Atoll returned by C-54 aircraft, arriving at Eniwetok Island at 1815 hours, which concluded the trip.

INCLOSURE NO. 2

Eniwetok Atoll, M.I.
30 April 1954

MEMORANDUM FOR: Senior Member, Survey Party

SUBJECT: Radiological Surveys of RONGELAP and UTIRIK Atolls

Submitted herewith is a report on the radiological survey of certain islands of the RONGELAP, UTIRIK and AILINGINAE Atolls conducted by the undersigned 21-23 April 1954. The contents of this report are organized as follows:

I. RONGELAP and AILINGINAE

1. Preliminary Remarks.
2. Methods.
3. Dose rates and doses.
4. Distribution of contamination.
5. Decontamination.
6. Food and water data.

II. UTIRIK

1. Preliminary Remarks.
2. Methods.
3. Dose rates and doses.
4. Distribution of contamination.
5. Food and water data.

Dr. Thomas White
LASL, Advisor to CTG 7.1

I Attachment:
Report

James G. Terrill, Jr.
PHS, Advisor to CTG 7.1

William M. Home
Captain, USA
Army Chemical Center

INCLOSURE NO. 3

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I. RONGELAP and AILINGNAE

1. PRELIMINARY REMARKS: Following the general conference at Kwajalein on 20 April, there was an informal conference between representatives of the Survey Team and Dr. John Bugher, Mr. Merrill Eisenbud, and CDR Cronkite and other members of Project 4.1, on the problem of sampling the Rongelap food and water supply and the soil. Mr. J. Tobin (Marshall District Anthropologist) supplied a detailed list of food materials, with the relative importance of each indicated. After considerable discussion of sampling methods, it appeared to be generally agreed that decisions on this complex problem might be postponed for the following main reasons:

a. Unless the radiation dose rate on Rongelap should be found to be far less than that expected from prior surveys, there would be no possibility of returning the natives to their homes for many months.

b. Current findings on contamination of the food supply, although of considerable inherent value, would be of little use in predicting the state of the food supply at some distant future date when the people might return.

It was therefore decided that the emphasis in the Rongelap survey would be on external radiation measurements and on decontamination problems; that although food, water and earth samples would be collected as permitted by other work, no special effort would be made to obtain analyses of these samples as a basis for any conclusions of this report. At this time the services of Lt. William Chapman, USN, were offered by Project 4.1 for the collection of food and soil samples for interested agencies.

2. METHODS: Gamma radiation dose rates, except where otherwise specified, were made with one or more AN/PDR-39 survey instruments at about three feet above ground level. Three such instruments were taken on the expedition, and they gave readings in good agreement with one another. Where contact readings are specified, the bottom of the instrument was placed in contact with the surface in question.

The results of the analysis of the food are only qualitative. The technique used in determining the radioactive content of the various food stuffs would be sensitive mainly to surface contamination. Self absorption of beta activity was not evaluated. Precise measurements using more sensitive techniques will be made by NRDL and NYOO. The technique used should detect contamination levels to approximately 80 DPM (4 X 10-5 uc) on the surface of samples, however.

The specific activity of the water samples was obtained by evaporating to dryness one milliliter of each of the samples in a glass counting cup and determining the activity in the resulting sample using a GM tube and Berkley scaler. Bismuth-210 was used as the standard to convert CPM to micro-curies per milliliter. The specific activity of the water samples from Rongelap indicate values that are roughly 10,000 times greater than the tolerance of 10-7 uc/ml beta activity established by the National Bureau of Standards

Handbook 52 for lifetime consumption. The Utirik samples varied from 100 to 1000 times the accepted tolerance. These data indicate the necessity for thorough cleaning of the cisterns before refilling for general consumption.

Existing conditions made it impractical to attempt any assay for the plutonium activity, which may be of importance in these samples.

3. DOSE RATES AND DOSES: Ailingnae Atoll, Sifo Island, 23 April, 6 mr/hr. All of the remaining report under the Rongelap-Ailingnae heading pertains to Rongelap Atoll.

On Rongelap Island, at the standard position established by Scoville, the reading at 0930 hours on 21 April was 17 mr/hr. This measurement, and those made on 11 and 26 March fit a decay formula $169t^{-1.526}$ r/day (t in days after 1 March) within about 3%.

On 22 April readings were made on other Rongelap Atoll Islands as follow

ISLAND	AVE.	MAX.	DECAY EXPONENT	STAKE LOCATIONS
Eniaetok	32 mr/hr	34 mr/hr	-1.4	2 stks-100 yds beach, just north at western peninsula
Busch	17 mr/hr	21 mr/hr	-1.46	1 stk-50 yds beach, center of path in south grove
Eniaelo	20 mr/hr	--------	(no prior data)	1 stk-south end of island

With reasonable precision, these readings (and that on Sifo Island) are related to previous observations by the same decay exponent.

4. DISTRIBUTION OF CONTAMINATION: Returning to the status of Rongelap Island, it was noted, as on the 26 March survey, that the readings over grave areas (about 15 mr/hr) were consistently lower than over grassy areas (about 20 mr/hr). The smooth concrete floor of the roofless church gave a contact reading of about 6 mr/hr, while the contact reading on the bordering gravel, about 18 mr/hr, was consistently higher than more distant gravel, about 15 mr/hr, as though the radioactive particles that landed on the concrete had been swept into the nearby gravel by the wind, (a similar phenomenon was noted on Parry Island during the Greenhouse Operation).

No exceptional contamination of sleeping mats was noted, but this question was not studied extensively. It was noted, however, that in those huts that had few openings, the contact readings on the floor, both on mat and on dirt, were exceptionally low (4 - 5 mr/hr).

Contamination of thatched roofs was noted, particularly on windward slopes, where the contact reading on the instrument was as much as 100% in excess of that obtained when the instrument was held at the same height above ground at some distance from the roof. However, since the excess reading onl

began to appear when the instrument was within about six inches from the roof, it seemed unlikely that decontamination of the roof would effect any substantial reduction of exposure of inhabitants in a hut.

A crude attempt was made to ascertain depth of penetration of radioactivity in a patch of soil near the center of the village. The place chosen was a bare patch of loose soil in a grassy area. Successive layers of about one inch in thickness was scooped up, each layer being put in a separate can, and then the radiations from the cans were compared on the beach where the background was much lower. The third layer had no detectable activity; the first layer had about six times the activity of the second. It is quite possible that all of the activity in the second layer may have come from spillage during removal of the first layer. An effort was made to collect an even thinner layer. The technique was even more unsatisfactory, but the results indicated that the activity per unit volume was several times greater in the thin layer than in the first inch. One can conclude that there was very little if any activity below two inches, and that the activity may be entirely superficial.

5. <u>DECONTAMINATION</u>: Since the state of the vegetation and the cisterns indicated that there had been little if any rain on the island, an attempt was made to find out whether future rains might effect any natural decontamination. The ship's crew mounted a portable gasoline-driven water-pump on the beach, connected a hose, and sprayed salt water on the thatched roof of one hut, and on a neighboring gravel area. The contact reading on the roof of the hut was reduced by 10% (after subtracting the general background from the readings, this indicates approximately 25% decontamination of the roof), but there was no noticeable reduction in contact readings on the floor of the hut or on the washed-down gravel area. While this experiment cannot be regarded as conclusive, it suggests that one should not be optimistic about the effect of future rains. It should be noted that Eniwetok Atoll experience on this subject is conflicting. During Operation Greenhouse, the heavy rains just prior to George Shot had little effect on the Dog Shot fall-out, but the rains that followed soon after the departure of the Task Force appear to have been fairly effective. However, even if the experience had been consistent, the terrain surfaces at Rongelap and Eniwetok are so different that it would be unsafe to draw conclusions.

It was evident that any attempt at artificial decontamination would be difficult and very expensive relative to the cost of supporting the population elsewhere until radioactive decay has reduced the radiation to an acceptable level. Decontamination operations of the type used on Eniwetok Atoll (bulldozing and grading) would not be applicable because of the total destruction of all vegetation and severe damage to the thin top-soil in the area covered. Any reasonable non-destructive decontamination effort would have to be a manual job.

I. RONGELAP AND AILINGNAE (CONT'D)

6. FOOD AND WATER DATA:

ITEM	DATE OF PROCUREMENT	ACTIVITY	DATE OF ANALYSIS
Drinking Water Cistern-Map 37*	4-21-54	2.52X10-3 uc/ml	4-25-54
Drinking Water (clear) Cistern-Map 49	"	8.03X10-4 uc/ml	"
Drinking Water (stirred) Cistern-Map 49	"	1.90X10-3 uc/ml	"
Drinking Water Cistern-Map 19	"	1.19X10-3 uc/ml	"
Drinking Water Cistern-Map 8	"	None	"
Well Water (Brackish) Well-Map 66	"	None	"
Jekru (Fresh) Collected on 4-22-54	4-22-54	2.52X10-3 uc/ml	4-25-54
Coconut Milk	4-23-54	None	4-25-54
Meat from Pandanus	4-22-54	None	4-25-54
Green Papaya-Interior	4-22-54	None	4-25-54
Ripe Papaya-Interior	4-22-54	None	4-25-54
Arrow Root-Interior	4-22-54	None	4-25-54
Swipe-Exterior Arrow Root	4-22-54	974 DPM	4-25-54
Swipe-Exterior Papaya	4-22-54	1640 DPM	4-25-54

* Refers to map of Native village - Rongelap Island - Rongelap Atoll

1. PRELIMINARY REMARKS: At the planning conference at Kwajalein on 20 April it was agreed that radiation levels at Utirik might allow an early return of the natives. Accordingly, it was decided to make a field study of food and water as well as an external radiation survey based on the pattern employed at Rongelap.

2. METHODS: External gamma dose rates were measured with AN/PDR-39 and MX-5 survey instruments. These instruments gave readings in good agreement with each other. Average readings integrated over the exposure time closely checked dosimeter readings.

3. DOSE RATES AND DOSES: Prior to this survey, no standard positions were established on this island. A standard position was established on April 23 at 1100 hours. The reading at this point and three feet above the ground was 3.0 mr/hr. An average reading in the vegetated area of the island was 2.8 mr/hr The readings about the buildings where gravel is prevalent averaged about 2.2 mr/hr. This data with the measurements made on 4 and 11 March fit a decay formula: $D_r=20t^{-1.42}$ r/day (t in days after 1 March)

This formula indicates that a level of 0.3 r/week would be reached in 75 to 80 days after 1 March, 15-20 May). An integration of the expected external dosage from 1 June 1954 to 1 Jun 1955 gives a 3.4 r exposure. This can be compared with the 3.9 r external gamma per year level established by the Atomic Energy Commission as a limit for off-site populations. The integrated external gamma dosage over the year beginning 1 June could be somewhat, but not significantly, higher if the decay rate leveled off to the conventional $t^{-1.2}$ rate.

4. DISTRIBUTION OF CONTAMINATION: The contamination was fairly uniformly distributed over the island. The highest reading out of doors at the 3 feet elevation was 3.3 mr/hr and the lowest was 2.0 mr/hr. There was some reduction in readings indoors, and this reduction was substantially larger, 60 percent in a large building like the church, as compared with a small building like a typical dwelling. Gravel areas (2.2 mr/hr) gave lower readings than the grassy areas (2.8 mr/hr).

The sleeping mats showed gamma readings (1.0 - 1.2 mr/hr) about half the levels outdoors (2.2 - 2.4 mr/hr) but beta plus gamma levels were somewhat higher (3.5 mr/hr) than the outdoor gamma readings. Contamination of the thatched roofs was noted. It was necessary to place the instrument close to (less than 3 feet) and perpendicular to the roof surface to consistently detect this effect with gamma measurements. The MX-5 picked up this increase in contamination more consistently when detecting both beta and gamma.

II. UTIRIK (CONT'D)

5. FOOD AND WATER DATA:

ITEM	DATE OF PROCUREMENT	ACTIVITY	DATE OF ANALYSIS
Drinking Water-Cistern near Church	4-23-54	$3.21X10^{-4}$ uc/ml	4-25-54
Drinking Water-Cistern-north settlement	4-23-54	$3.90X10^{-4}$ uc/ml	4-25-54
Brackish Well Water-200 yds south of Church-unprotected hole	4-23-54	$5.3X10^{-5}$ uc/ml	4-25-54
Clear Well Water-350 yds south of Church-corrugated metal siding & cover	4-23-54	$7.3X10^{-5}$ uc/ml	4-25-54
Milk from Bread Fruit	4-23-54	None	4-25-54
Solids from Bread Fruit	4-23-54	None	4-25-54
Ripe Papaya-Interior	4-23-54	None	4-25-54
Green Papaya-Interior	4-23-54	None	4-25-54
Arrow Root-Interior	4-23-54	None	4-25-54

Eniwetok Atoll, M.I.
30 April 1954

CONSTRUCTION REQUIRED TO ESTABLISH TEMPORARY VILLAGE

We (Holmes & Narver, Inc.) are herewith submitting the following Bill of Material and cost estimate to construct a temporary village on the island of Bikej in the Kwajalein Atoll, Marshall Islands.

The cost estimate outlined below is based on the following:

1. Construction is to be on Bikej Island.

2. H&N will furnish all material.

3. The Navy will transport the material to Bikej Island - (no cost included).

4. H&N will furnish one (1) carpenter foreman, two (2) carpenters and one (1) heavy equipment operator.

5. The Navy Station Kwajalein is to furnish the four (4) H&N men housing and transportation between Kwajalein and Bikej - (no cost included for transportation).

6. That heavy equipment required (grader, etc) is available at Kwajalein (no cost included for equipment).

7. That natives are available for labor and as carpenter assistants - (no wages for natives included, but will be funded by JTF SEVEN).

8. That the H&N carpenters are furnished with an interpreter.

9. H&N will furnish portable generator and power saw.

10. Tools for native labor will be furnished by Navy Station Kwajalein.

SUMMARY OF MATERIAL

Framing Lumber	44552 B.F.
Framing Nails (Aluminum)	9 Kegs
Nails for Plywood (Aluminum)	3 Kegs
Corrugated Aluminum Roofing	16944 Sq. Ft.
Aluminum Ridge Cap	744 Lin. Ft.
Aluminum Gutter	1636 Lin. Ft.
Plywood, 3/8"	727 Sheets
Plywood, 1/2"	410 Sheets
Wood Doors	44
Door Handles	48
Door Hinges	48 Pair
Seat Hinges	8 Pair
Shutter Hinges	152 Pair
Eye Bolts with Hooks	400

Paint	52 Gals.
Screening	256 Sq. Ft.
Nailing Strips, 1" X 1"	350 Lin. Ft.
Screen Door	4
Mess Tables, 8' Long	11

MATERIAL COSTS

		Labor	Material	
Lumber	44552 B.F.		.10	4455
Rough Hardware Nails	12 Kegs		12.00	145
Corrugated Metal Sheets	16994 S.F.		.22	3740
Aluminum Ride Cap	744 L.F.		.156	115
Aluminum Sheet for Gutter	1636 L.F.		.20	325
3/8" Plywood	23264 S.F.		.18	4190
1/2" Plywood	13120 S.F.		.22	2885
Single Flush Doors	44 ea		13.00	570
Door Handles	48 ea		.20	10
Door Hinges	48 Pr.		1.75	85
Seat Cover Hinges	8 Pr.		.65	5
Shutter Hinges	152 Pr.		.80	120
Eye Bolts & Hooks	400 ea		.15	60
Screening	256 S.F.		.15	40
Screen Door	4 ea		10.00	40
1 x 1 Nailing Strips for Screening	350 L.F.		.15	55
Paint	52 Gal.		3.75	195
Mess Tables	11 ea.		11.50	130
H&N Carpenters 3 for 3 weeks = 54 Man Days		1510		
H&N Heavy Duty Man 1 Week = 7 Man Days		195		
	TOTAL COST -	1705.00		17,165.00

The above total of 17,165 includes man power furnished by H&N.

The above bill of material is needed to construct the temporary village in accordance with the drawings number Misc. 255 and 256 showing the sizes and construction of the various buildings required and as stated in memorandum letter dated April 27, 1954 from Mr. Marion Wilds, Acting Destad Rep. Ebeye - for the Trust Territory of the Pacific Islands.

No provisions for cisterns are being made at this time for the temporary village at Bikej as there is available on the island (2) 15,000 gallon cisterns which only need cleaning and filling.

At the time the natives are returned to their island of Rongelap, there will be a need to construct new roofs over cisterns, the cost of which will have to be included in the cost of moving the natives from Bikej Island to Rongelap Island. Also at this time to include cost of repair or replacement due to damage by storm during the interval the natives are away.

2 Attachments:
1. H&N drawing No. Misc 255
2. H&N drawing No. Misc 256

INCLOSURE NO. 4

3
H-107

UNITED STATES PACIFIC FLEET
HEADQUARTERS OF THE COMMANDER IN CHIEF

CINCPACFLT FILE
FF1-1
A11
Ser 01339
17 JUN 1954

From: Commander in Chief U. S. Pacific Fleet
To: Commander Joint Task Force Seven

Subj: Survey of Rongelap and Utirik Atolls

Ref: (a) CJTF SEVEN CONF ltr J-3/141.8 of 1 May 1954
(b) CINCPAC CONF Msg 160501Z of Apr 1954
(c) CNO CONF Msg 111955Z of May 1954
(d) CINCPAC UNCL Msg 122157Z of May 1954
(e) CINCPACFLT CONF Msg 112214Z of May 1954
(f) CINCPACFLT CONF Msg 142006Z of May 1954
(g) CJTF SEVEN CONF Msg 120436Z of May 1954
(h) CJTF SEVEN CONF Msg 140430Z of May 1954

1. Reference (a) forwarded the report of the survey party which visited Rongelap and Utirik Atolls during the period 21-23 April 1954 in order to determine requisite action for rehabilitation of these atolls prior to return of inhabitants who were evacuated incident to hazards resulting from the first test in the CASTLE series. CJTF SEVEN concurred in the recommendations of the survey report and requested to be advised of CINCPAC's approval of these recommendations.

2. Reference (b) apprised CNO of CINCPAC's views and CJTF SEVEN's preliminary advice on the matter of rehabilitation. This was approved by CNO in reference (c) which further stated that no funds other than normal support should be expended without prior approval.

3. CINCPAC delegated responsibility for the subject matter to CINCPACFLT in reference (d) and further directed CJTF SEVEN to report to CINCPACFLT for the tasks outlined.

4. In reference (e) and (f), CINCPACFLT provided guidance for the resolution of certain matters in connection with rehabilitation of the Rongelap and Utirik natives.

5. CJTF SEVEN informed cognizant commanders of the detailed plans for native rehabilitation in references (g) and (h).

6. On the basis of the foregoing action, CINCPACFLT considers that all basic questions pertinent to native rehabilitation have been resolved and that action is proceeding satisfactorily. As a matter of record, CINCPACFLT's action on the recommendations of the survey report is summarized in the

following paragraphs. This summary will also serve the purpose of providing guidance for matters of possible future occurrence until completion of the native rehabilitation project.

7. Comments on the specific recommendations of the survey party contained in paragraph 4 of enclosure (1) to reference (a) are listed after each recommendation which is quoted for convenient reference:

a. UTIRIK

(1) "Several days after the last CASTLE shot, Utirik Atoll should be inspected again by RadSafe personnel of JTF SEVEN or AEC to determine whether or not additional contamination has occurred. If no increase in external radiation and food and water contamination levels is noted, the return of the natives may be undertaken without delay. The contamination levels now present at the two atolls are indicated in Inclosure 3. Research analysis of the foods and water collected is being made by NRDL and NYOO."

COMMENT: Concur.

(2) "CINCPACFLT should designate a project officer to coordinate the activities of interested agencies in the return of the Utirik natives."

COMMENT: Reference (f) provided for CO NAVSTA KWAJALEIN to coordinate the project and act as the local representative of CINCPACFLT in the discharge of CINCPACFLT responsibilities in connection with the subject project. It further provided for CO NAVSTA KWAJALEIN to designate a project officer at his discretion.

(3) "CINCPACFLT should designate and make available a ship which will transport the Utirik natives and their belongings from Kwajalein back to Utirik. In addition to the few personal affects the natives have with them, the following items should be moved to Utirik. These items should be assembled by the CINCPACFLT project officer in coordination with the local Kwajalein representative of TERPACIS, and the funds for necessary purchases should be provided by JTF SEVEN:

(a) Used lumber, already made available by ComNavSta Kwajalein.

(b) Floud, salt and other staple items of food supplies adequate for one month.

(c) Limited amounts of nails, window glass, metal roofing and medical supplies as determined by CINCPACFLT project officer in coordination with Kwajalein representative of TERPACIS.

(d) 10,000 gallons of fresh water to flush and refill Utirik cisterns.

(e) Approximately 400 chickens, 120 pigs and small numbers of other animals as determined by CINCPACFLT project officer, in coordination with TERPACIS representative. Some of these animals are already being obtained by the TERPACIS representatives at Kwajalein."

COMMENT: LST 1157 being utilized as provided for in references (e), (g) and (h). Reference (e) authorized the provision of certain supplies by CO NAVSTA KWAJALEIN subject to his discretion. CINCPACFLT has no project officer for determination of numbers of animals to be provided. This determination and detailed arrangements regarding animals are considered to be HICOMTERPACIS responsibilities.

(4) "The survey party was advised that on a number of occasions LST's have entered the Utirik lagoon. The use of this type ship is recommended, if the CINCPACFLT project officer concurs after investigation of the lagoon channels."

COMMENT: Concur subject to requirements of safe navigation as determined by the LST commanding officer.

(5) "No construction or repair work by U.S. personnel is required, since little deterioration of the buildings on Utirik has occurred since the evacuation."

COMMENT: Satisfactory to CINCPACFLT in consideration of the fact that CJTF SEVEN is best equipped to evaluate this matter and has concurred with this recommendation.

(6) "no decontamination work is required, except for the flushing and cleaning of cisterns recommended above."

COMMENT: Concur subject to the same comments in subparagraph 7.a.(5) above.

b. RONGELAP

(1) "The natives of Rongelap Atoll should be relocated on an island of the Kwajalein Atoll for the period of approximately one year. BIKEJ Island has been selected by TERPACIS representatives at Kwajalein for this purpose. This island is under control of TERPACIS. COMNAVSTAKWAJ concurs in this selection. The relocation near NAVSTA Kwajalein is in accord with the recommendations of the Project Officer of Project 4.1, who will shortly conclude the active medical surveillance of the Rongelap natives at Kwajalein.

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COMMENT: Majuro Atoll has been selected as the site for temporary relocation of the Rongelap natives, upon representation of HICOMTERPACIS for reasons of native welfare, as set forth in reference (e).

(2) "As in the case of the Utirik natives, CINCPACFLT should designate a project officer to coordinate the activities of interested agencies during the temporary relocation of Rongelap natives and during their ultimate return to their homes."

COMMENT: Reference (f) provided for COMNAVSTAKWAJALEIN to coordinate movement of the Rongelap natives to Majuro. Responsibility for their welfare during their temporary residence on Majuro rests with HICOMTERPACIS, CINCPACFLT will arrange for necessary coordination in connection with their ultimate return to Rongelap at a later date.

(3) "The temporary nature of this relocation should be given wide publicity throughout the Trust Territories and U. S. news media, after the movement has been completed."

COMMENT: Concur. It is considered that this matter should be and is being handled at departmental level by the Atomic Energy Commission, Department of Defense, Department of Interior and other interested government agencies. It is assumed that HICOMTERPACIS will provide for appropriate publicity within the Trust Territories.

(4) "The AEC contractor at the Pacific Proving Grounds (Holmes and Narver, Inc.) should prefabricate as necessary and supervise the construction of small wood dwellings, a combination school and church, a dispensary, and other buildings and cisterns for the 82 Rongelap natives to be relocated temporarily in the Kwajalein Atoll. Materials for this construction will be provided from Eniwetok and delivered to the site of the new village by JTF SEVEN. Details of the construction required are presented in Inclosure 4."

COMMENT: Concur, except for substitution of Majuro vice Kwajalein as the temporary relocation site.

(5) "Common labor for this construction should be provided by the natives of Rongelap themselves, as much as possible. Holmes and Narver personnel will perform the more difficult tasks. Native labor should be paid wages by JTF SEVEN at a wage scale determined by the representatives of TERPACIS."

COMMENT: Concur.

(6) "Water and staple food supplies for one month should be provided initially, as in the case of the Utirik natives covered above. Likewise, chickens and animals should be provided in numbers determined by representatives of TERPACIS and the CINCPACFLT project officer. In addition, the Rongelap natives must be provided minimum food supplies and other essentials on a continuing basis, since they will have no income from sale of copra and

since BIKEJ Island provides meager quantities of natural foods."

COMMENT: Concur subject to pertinent remarks previously expressed in references (b) and (e). CINCPACFLT has no project officer for determination of numbers of livestock to be provided. This determination and necessary procurement arrangements are considered to be HICOMTERPACIS responsibilities.

(7) "Just prior to the time the Rongelap natives are moved from Kwajalein Island to BIKEJ Island, a ship should be sent to Rongelap Island to pick up the clothing, books and other belongings (including two 30-foot sloops) of the natives. Decontamination of these items should be performed at Kwajalein under supervision of local or JTF SEVEN Radsafe personnel."

COMMENT: Arrangements for transfer of Rongelap natives boats and personal effects to Majuro in LST 1157 have been made by COMNAVSTA KWAJALEIN.

(8) "Periodic medical surveys of the natives and Radsafe surveys of the atolls should be conducted by qualified personnel operating out of NavSta Kwajalein. Dr. Bugher, DBM, AEC, stated that his office would periodically send groups of qualified personnel to Kwajalein for this purpose."

COMMENT: Concur.

(9) "AEC RadSafe personnel resident in the Pacific Proving Grounds in conjunction with representatives of DBM, AEC, should make periodic inspections of the islands of Rongelap Atoll to ascertain the rate of decay of the contamination. Reports of these inspections should be forwarded to interested agencies; AEC, CINCPACFLT, JTF SEVEN, COMNAVSTA KWAJALEIN.

COMMENT: Concur.

(10) "A representative of CINCPACFLT, probably COMNAVSTAKWAJ, should monitor the general welfare of the Rongelap natives during their temporary stay at Kwajalein Atoll."

COMMENT: Monitoring of general welfare of natives, wherever located, is a continuing responsibility of HICOMTERPACIS.

(11) "In the spring of 1955, another survey party should visit the islands of Rongelap Atoll and the natives in their temporary homes at Kwajalein Atoll to determine when these natives may be returned to their homes and what additional action must be taken prior to their movement from Kwajalein Atoll. The same agencies should be represented on this later survey party as on this group. Funds required for this movement and the construction and supplies necessary at Rongelap Island will be provided by JTF SEVEN."

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COMMENT: Concur, subject to substitution of Majuro vice Kwajalein as the site of temporary residence of the Rongelap natives.

8. CJTF SEVEN is requested to confirm that the AEC will undertake participation indicated in paragraphs 7.b.(8) and 7.b.(9).

9. By copy of this letter, HICOMTERPACIS is requested to advise as to whether he concurs in the actions indicated in this letter, and specifically to confirm the understandings as to matters for which HICOMTERPACIS assumes as indicated in the "COMMENTS" in paragraphs 7.a.(3), 7.b.(2), 7.b.(3), 7.b.(6), &.b.(10).

10. CJTF SEVEN is requested to provide copies of reference (a) to all information addressees listed for distribution in this letter. Further distribution of reference (a) at the discretion of CJTF SEVEN is authorized, provided a copy of this letter is bound with each copy of reference (a) so distributed.

H. G. HOPWOOD
Chief of Staff

Copy to:
CNO (5 copies)
CINCPAC
COMHAWSEAFRON
CO NAVSTA KWAJALEIN
HICOMTERPACIS

AUTHENTICATED

/s/ A. R. Olsen
A. R. OLSEN
Flag Secretary

HEADQUARTERS
JOINT TASK FORCE SEVEN
WASHINGTON 25, D.C.

J-3/729.3

6 July 1954

SUBJECT: Responsibilities for Care and Disposition of Native Inhabitants of Rongelap and Utirik Atolls

TO: Manager
Santa Fe Operations Office
P. O. Box 5400
Albuquerque, New Mexico

1. Mr. James E. Reeves of your agency telephoned this headquarters 16 June and discussed with Colonel Byars, J-3 Division, Headquarters JTF SEVEN, the status of Mr. Thomas A. Hardison as representative of General Clarkson on matters concerning the care and disposition of evacuated natives. The question is pertinent since you assumed on 2 June full responsibility for all AEC matters pertaining to the Pacific Proving Grounds.

2. On 14 May 1954, CINCPACFLT requested CJTF SEVEN to advise that agency of the name of the person who would represent CJTF SEVEN in the Forward Area after the personnel of Headquarters, JTF SEVEN returned to Washington. In order to avoid the necessity of leaving indefinitely at Eniwetok a staff officer of this headquarters, CJTF SEVEN designated Mr. Hardison his representative at Eniwetok in connection with the disposition of native inhabitants of Rongelap and Utirik Atolls. Mr. Hardison visited Kwajalein and Majuro Atolls several times and was eminently well-qualified to act as representative of CJTF SEVEN in this matter.

3. As you know, the native inhabitants of Utirik Atoll have been returned from Kwajalein to their home island. The native inhabitants of Rongelap Atoll have been temporarily relocated for a period of about one year on Ejit Island of Majuro Atoll, while the radioactive contamination of Rongelap decays to acceptable levels. It is not now contemplated that extensive construction or repair will be necessary on Rongelap Island when the inhabitants of that atoll are returned to their homes. Consequently, it is doubtful that Holmes and Narver, Inc., and the AEC Resident Engineer at Eniwetok will be called upon to take further action in regard to the care and disposition of the natives. Mr. Hardison is, therefore, relieved of any responsibility as CJTF SEVEN representative in this matter.

4. The responsibilities of interested agencies for the continued care and disposition of the natives of Rongelap and Utirik Atolls are delineated for your information as follows:

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a. CINCPAC has overall responsibility under the Department of Defense for the completion of the project for the restoration of atolls, with AEC assistance, and for the return of inhabitants. CINCPAC delegated to CINCPACFLT its responsibility in this connection. CINCPACFLT instructed COMNAVSTAKWAJ to coordinate and act as its local representative in the discharge of CINCPACFLT responsibilities in connection with the displaced natives. COMNAVSTAKWAJ designated LCDR Robert W. Wells the Project Officer to represent CINCPACFLT interests.

b. The routine welfare and care of all Marshall Island natives are continuing responsibilities of the High Commissioner, Trust Territory of the Pacific Islands, as agent for Department of the Interior.

c. The Division of Biology and Medicine, AEC, will continue to monitor the physical condition of the native inhabitants of Rongelap and Utirik Atolls who were exposed to radioactive contamination as a result of the first shot of the CASTLE series. Parties of medical and radsafe personnel under the direction of Division of Biology and Medicine, AEC, will visit the natives and the atolls concerned periodically in order to observe the medical progress of the natives and to ascertain the earliest possible time for the return of the Rongelap natives to their homes. The first visit of this AEC-sponsored group is planned for August or September of this year. Representatives of this headquarters will accompany the AEC party.

d. JTF SEVEN naturally has a continuing interest in this matter. JTF SEVEN has furnished funds to pay certain medical expenses for the natives while at Kwajalein, for the procurement of livestock to replace that lost as a result of the contamination, for the construction of a temporary village at Majuro Atoll, for the purchase of food and clothing supplies, and for other purposes. JTF SEVEN will continue to provide funds for the provision of food for the Rongelap natives while they are at Majuro and will pay for initial food stocks when they are returned to their homes. CTG 7.2 will represent CJTF SEVEN at Eniwetok in connection with the disposition of Utirik and Rongelap natives, in the event any problem arises which can and must be handled at the Pacific Proving Grounds.

5. Santa Fe Operations Office has no routine responsibilities for the continued care and disposition of these natives. The erection of the temporary village at Majuro under the supervision of Mr. Hardison was per-

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formed with promptness and efficiency. According to reports received here, the construction is excellent. The assistance and cooperation provided by Mr. Hardison and his assistants is greatly appreciated.

FOR THE COMMANDER:

/s/ E. McGinley
/t/ E. McGINLEY
Major General, U.S. Army
Chief of Staff

Copy furnished:
Mr. T. ... Hardison
USAEC, Eniwetok

CTG 7.2, Eniwetok

AEC/DMA, ATTN: Lt Col
Greenberg

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